6th Internacional Conference on Nonlinear Science and Complexity

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INPE - National Institute for Space Research
São José dos Campos - SP - Brazil

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16 - 20 May 2016

Sponsors:

siam CAPES FAPESP

Organizers:

INPE Ministério da Ciência, Tecnologia e Inovação

GOVERNO FEDERAL BRASIL PÁTRIA EDUCADORA

Forwards and Welcome Message

The *International Conference on Nonlinear Science and Complexity – NSC*, was created in 2006. In this same year, Beijing, in China, hosted its first edition. Since then, this conference takes place each year and have being considered as the main scientific scenario that provides a place to exchange recent developments, discoveries and progresses on Nonlinear Science and Complexity. The aims of the conference are to present the fundamental and frontier theories and techniques for modern science and technology, and to stimulate more research interest for exploration of nonlinear science and complexity. The conference will focus on fundamental theories and principles, analytical and symbolic approaches, computational techniques in nonlinear science, nonlinear mathematics, and complexities.

At this edition, the following subjects will be particulary address: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications; Bifurcation Analysis and Applications; Celestial Mechanics and Dynamical Astronomy; Chaos and Global Nonlinear Dynamics; Climate Dynamics; Complex Networks; Control in Complex Systems; Control of Chaos; Discontinuous Dynamical Systems; Discrete Dynamical Systems; Epidemiology and Mathematical Models; Fluidodynamics, Plasma and Turbulence; Geophysical Nonlinear Dynamics; Modeling, Numerical Simulation and Optimization; Nonlinear Dynamics and Complex Systems; Nonlinear Dynamics in Lasers; Nonlinear Dynamics in Thermal and Fluid Sciences; Nonlinear Dynamics of Systems with Infinite Dimension; Nonlinear Fractional Dynamics and Applications; Nonlinear Systems and Neural Dynamics; Stochastic Models; Synchronization in Nonlinear Systems; System Biology; Time Series Analysis.

We are very proud to organize the sixty edition of this so relevant international meeting in Sao Jose dos Campos, Brazil, at National Institute for Space Research - INPE. As so, on behalf of the Organizing Committee, we would like to welcome you in São José dos Campos, Brazil, for the *"6th International Conference on Nonlinear Science and Complexity – NSC-2016*". Also, we would like to express our profound gratitude for your keen interest and very enthusiastic support shown for this conference.

We would also like to thank everybody who joints us in the organization of this conference. It includes all the sponsors for their technical and financial support; all the participants for their contributions; all the committee members for their work and follow-through. We also expect that you have the opportunity to make friends, exchange scientific knowledge and establish collaborations that allow meaning contributions to the field of nonlinear science and complexity.

For the Organizing Committee,

Elbert E. N. Macau Mark Edelman Miguel A. F. Sanjuan

Conference Organizing Committee

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Acknowledgment

The organizers would like to thanks Prof. Jason Gallas, whom provides the Figure that was used to create the NSC-2016 logo. This Figure, in Prof. Gallas words, is "a stability diagram of a model of prey-predator system including the dormancy of predators, a model aiming to elucidate the paradox of enrichment in the context of ecosystems."

Conference Information

Registration

Registration for the conference Will be open at the following times, in the LIT / Fernando de Mendonça Auditory atrium:

Monday, May 16th	8:00 AM – 5:00 PM
Tuesday, May 17th	8:00 AM – 2:00 PM
Wednesday, May 18th	8:00 AM – 2:00 PM
Thursday, May 19th	8:00 AM – 2:00 PM
Frieday, May 30th	8:00 AM – 11:00 AM

Internet

Wireless internet access is available in the LIT building. The network available is *LIT_VISITANTES* which password is *Jf37DmcNNQ*.

Lunch breaks

The lunch will be served in the INPE's restaurant (see map), all days, from 12:15 PM to 13:30 PM. It will cost about 29.00 BRL per kilo. Alternatively, there is also a cafeteria, which besides lunch also offers coffee, drinks and snacks during all day.

Poster Sessions – Tuesday and Thursday, May 17, 19, 1:30 PM – 3:30 PM

Banquet – Wednesday, May 18, 7:00 PM – 10:00 PM

The banquet will take place at INPE's recreation area (see map), nearby LIT. There will be a buffet with salads and vegetables. The main disch will be the Brazilian barbecue served in an all-you-can-eat basis. The following drinks are included (up 4 to each person): water, soft drinks, juices and beer, and caipirinha (up to 3 for person).

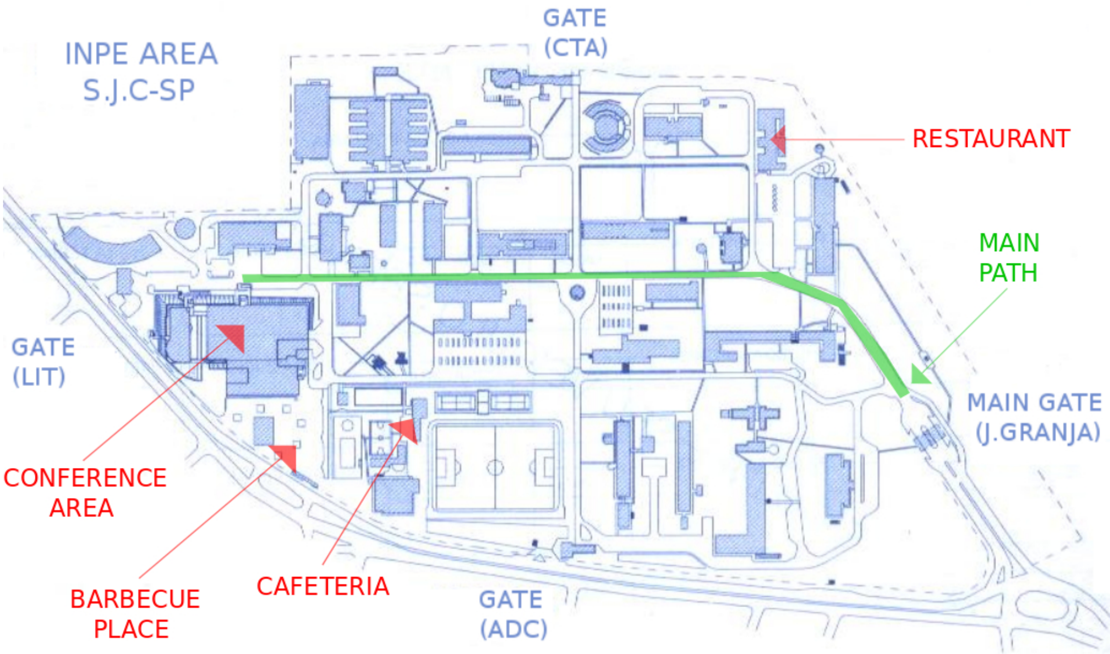
The banquet is included in the full registration fee. Additional tickets (for accompanying persons or for the ones who did nor pay full registration fee) can be purchased at the registration desk.

Coffee-Breaks

All coffee-breaks will be served in in the LIT / Fernando de Mendonça Auditory atrium.

How to get INPE from Sao Paulo and Rio de Janeiro

INPE Campus


INPE AREA
S.J.C-SP
GATE
(CTA)
RESTAURANT
MAIN
PATH
GATE
(LIT)
MAIN GATE
(J.GRANJA)
CONFERENCE
AREA
BARBECUE
PLACE
CAFETERIA
GATE
(ADC)

Zaslavsky Award Speech

Systems with power-law memory and fractional dynamics

– Mark Edelman
Stern College at Yeshiva University, New York, USA;
Monday, May 16th, 2016
FM auditorium -Second Floor

Dr. Mark Edelman received his PhD in Astrophysics from the Odessa State University, former USSR. For a long time he worked as a Research Scientist and a Senior Research Scientist at the Rostov State University and Rostov Pedagogical Institute, Rostov-on-Don, USSR. From 1993 to 2010 he worked at the Courant Institute of Mathematical Sciences, New York University, New York City, USA, as a research scientist. His broad scientific interests include cosmic gas dynamics, corrugation instability of shock waves, nonlinear dynamics, chaos theory, fractional calculus. His present scientific activity is concentrated on the fractional dynamical systems and systems with power-law memory. He is a member of the editorial boards of "Journal of Applied Nonlinear Dynamics" and "Fractional Calculus and Applied Analysis". His recent publications include three book chapters and numerous journal articles. He was Invited Speaker at numerous international conferences He has received the American Astronomical Society Grant awarded for the inves tigation of the stability of oblique MHD shock waves. Since 2009 Dr. Edelman has been teaching various physics courses and supervising student's research at Stern College for Women, Yeshiva University, simultaneously continuing his research at the Courant Institute.

Abstract: Systems with power-law memory are common in natural and social sciences and engineering. The most appealing is appearance of power-law memory in biological applications. A consistent consideration of discrete systems with power-law memory can be done through the use of fractional Eulerian numbers. It can be shown that systems with power-law memory can be described by fractional difference/differential equations.

Due to the integro-differential nature of fractional derivatives, investigation of general properties of fractional differential equation is very difficult. To investigate general properties of fractional dynamics we consider fractional maps, which can be derived from fractional differential equations with periodic kicks or, in the case of essentially discrete systems, from fractional difference equations. Using the fractional standard map (harmonic nonlinearity) and the fractional logistic map (quadratic nonlinearity) as examples we show that nonlinear systems with power-law memory demonstrate a new type of attractors - cascade of bifurcation type attractors, power-law convergence/divergence of trajectories, bifurcations with changes in the memory parameter, intersection of trajectories, and overlapping of attractors.

Lagrange Award Speaker

Hopf bifurcation and chaos in a third-order phase-locked loop
– *José Roberto Castilho Piqueira*

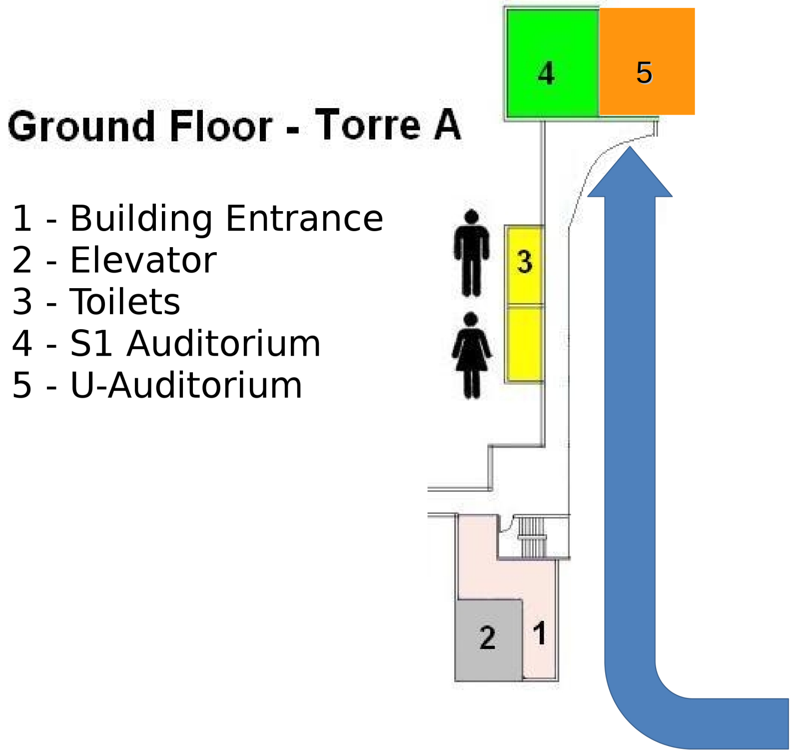
Escola Politécnica da Universidade de São Paulo, São Paulo-SP, Brazil;

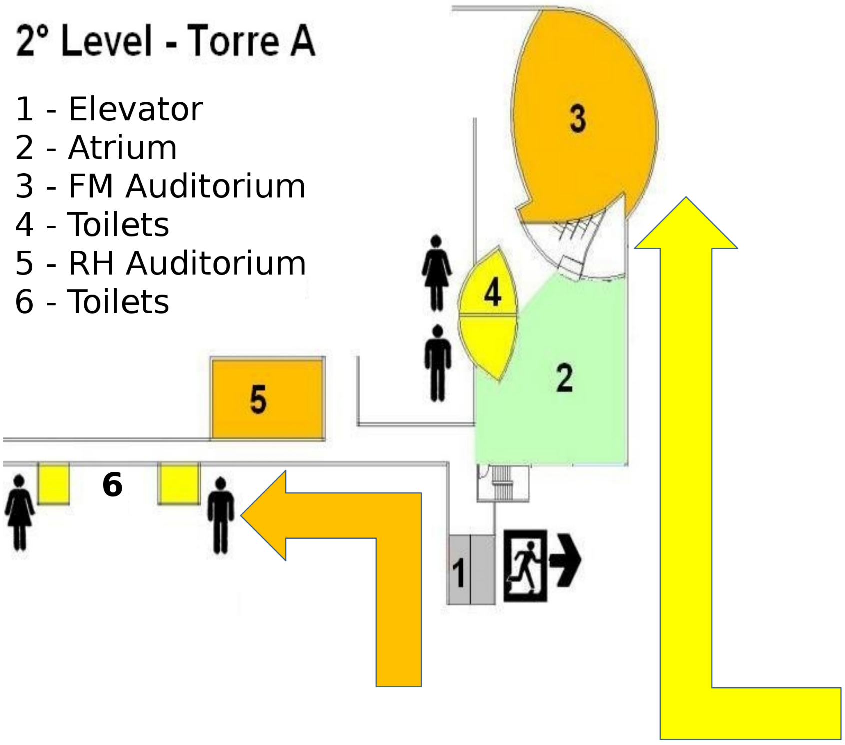
Tuesday, May 17th, 2016
FM auditorium -Second Floor

Dr. José Roberto Castilho Piqueira was born in Sorocaba, SP, Brazil, in 1952. He received the B.S., M.S., and Ph.D. degrees in electrical engineering from Universidade de São Paulo in 1974, 1983, and 1987, respectively. From 1974 to 1994, he worked in several telecommunication projects for Brazilian electronic and service industries, designing and developing circuits, equipments, and systems. Since 1994, he has been dedicated to teaching and research at Escola Politécnica da Universidade de São Paulo, and participating in projects for Brazilian Oil Agency and Brazilian Navy. Currently, he is a Full Professor and Dean of São Paulo Engineering School, working with time distribution networks and running a laboratory where analytical and numerical studies support electronic and optical experiments, considering the several possible topologies and quantum control models. Besides, as synchronous complex networks appear in many aspects of human life, he works with some biological models by using differential equations and proposing complexity measures for some spreading phenomena. Considering his areas of interest, he published a hundred of complete papers in international periodicals and congress proceedings, indexed in the Web of Science.

Abstract: Phase-locked loops (PLLs) are devices able to recover time signals in several engineering applications. The literature regarding their dynamical behavior is vast, specifically considering that the process of synchronization between the input signal, coming from a remote source, and the PLL local oscillation is robust. For high-frequency applications it is usual to increase the PLL order by increasing the order of the internal filter, for guarantying good transient responses; however local parameter variations imply structural instability, thus provoking a Hopf bifurcation and a route to chaos for the phase error. Here, one usual architecture for a third-order PLL is studied and a range of permitted parameters is derived, providing a rule of thumb for designers. Out of this range, a Hopf bifurcation appears and, by increasing parameters, the periodic solution originated by the Hopf bifurcation degenerates into a chaotic attractor, therefore, preventing synchronization.

LIT Conference Center





Technical Sessions at Glance

Time	Monday	Tuesday	Wednesdays	Thursday	Friday
8:00 – 8:30	Registration	Registration	Registration	Registration	Registration
8:30 – 09:00	Open Ceremony	MS-3b / MS-4b / TS-04	MS-6a / TS-07 / TS-08	MS-7a / MS 6b / TS-5	MS-7b / TS-12 / TS -13
9:00 – 10:30	MS-1a / MS-2a / TS-01				
10:30 – 10:45	Coffee-Break	Coffee-Break	Coffee-Break	Coffee-Break	Coffee-Break
10:45 – 11:30	P1	P4	P7	P9	P13
11:30-12:15	P2	P5	P8	P10	P14
12:15-13:30	Lunch	Lunch	Lunch	Lunch	Lunch
13:30 – 15:30	MS-1b / MS-2b / TS-02	Poster-1	Practical activities	Poster-2	TS-14 / TS-15 /TS-16
15:30 – 15:45	Coffee-Break	Coffee-Break	Coffee-Break	Coffee-Break	Coffee-Break
15:45 – 16:30	P3	P6	Practical activities	P11 / P12	P15
16:30 – 18:30	MS-3a / MS-4a / TS-03	MS-3c / MS-5 / TS-06	Discussions	MS-8 / TS-9 / TS-10/ TS-11	P16 , Poster Award & Closing ceremony

Plenaries

- P-01 – ***Jason Gallas***, Universidade Federal da Paraíba-PB, Brazil; Periodicity and chaos:
  How are they organized in lasers, circuits, biochemical oscillators and other complex flows?
- P-02 – **Christian Bick**, University of Exeter, Exeter, United Kingdom;
  Dynamics of Phase Oscillators with Generalized Coupling
- P-03 – ***Mark Edelman***, Stern College at Yeshiva University, New York, USA.
  Systems with power-law memory and fractional dynamics
- P-04 – ***Miguel Sanjuán***, King Juan Carlos University, Mósteles, Madrid, Spain.
  Basin Entropy: A new tool to explore uncertainty in dynamical systems
- P-05 - ***Lev A. Ostrovsky***, National Oceanic and Atmospheric Administration (NOA), Boulder, CO, USA;
  Acoustic radiation force, dynamics of particles and bubbles in acoustic field, and biomedical applications.
- P-06 – ***José Roberto Castilho Piqueira***, Escola Politécnica, USP, Brazil;
  Hopf bifurcation and chaos in a third-order phase-locked loop
- P-07 – ***Martin Mönnigman***, Ruhr-Universität Bochum, Germany;
  Constructive Nonlinear Dynamics: Integrating Applied Bifurcation Theory with Optimization.
- P-08 – ***Lea F. Santos***, Yeshiva University, New York, USA;
  Powerlaw Decays and Thermalization in Chaotic Quantum Systems.
- P-09 – ***Luis Fernando Costa Alberto***, USP de São Carlos, Brazil;
  Avoiding Blackouts with Theory of Stability Regions.
- P-10 – ***J. A. Tenreiro Machado***, Politécnica do Porto, Porto, Portugal;
  Fractional calculus and applications.
- P-11 – ***J. M. Martínez***, IMECC, UNICAMP, Brazil;
  Complexity in Unconstrained and Constrained Optimization.
- P-12 – **Matteo Tanzi**, Imperial College, London, UK;
  Expanding Dynamics on Heterogeneous Networks: Mean Field Reduction and Synchronisation.
  P-13 – ***Mike Field***, Imperial College London, London, United Kingdom and Rice University, Houston, USA;
  A Modularization of dynamics theorem for asynchronous networks.
- P-14 – ***Albert C. J. Luo***, Southern Illinois University, USA;
  Complete route of period-1 motions to chaos in a time-delayed Duffing oscillator.
- P-15 – **Thomas Kapitaniak**, Technical University of Lodz, Poland
  Synchronization of pendula: From Huygens to chimeras
- P-16 – ***Gonzalo M. Ramirez-Ávila***, Universidad Mayor de San Andrés, La Paz, Bolivia;
  Arithmetic progression of spiking and bursting in Rulkov's Model

Symposia

MS-1: TRANSIENT CHAOS IN COMPLEX SYSTEMS

Abraham Chian[1], Erico Rempel[2] , and Miguel Sanjuán[3]

[1]ITA, INPE & University of Adelaide, São Jose dos Campos & Adelaide, Brazil & Australia, abraham.chian@gmail.com
[2]ITA & INPE, São Jose dos Campos, Brazil, erico_rempel@yahoo.com.br
[3]Universidad Rey Juan Carlos, Madrid, Spain, miguel.sanjuan@urjc.es

Description: Transient chaos refers to chaotic phenomena that appear in a finite lifetime. In contrast to permanent chaos associated with the asymptotic state, transient chaos are associated with a nonequilibrium state that has different behavior from the asymptotic behavior of a system. Examples of complex phenomena and dynamical structures related to transient chaos are: chaotic saddles, chaotic leaking systems, crises, on-off intermittency, edge of chaos, chaotic advection, fractal basin boundaries, transport barriers, and turbulence. This mini-symposium aims to discuss the concepts and applications of transient chaos in astrophysics, biology, fluids, and plasmas.

MS-2: Chaos, scaling laws and dynamical systems

André Luís Prando Livorati[1]

[1]Departamento de Física – UNESP Rio Claro -SP, Brazil, livorati@rc.unesp.br

Description : The aim of this minisymposium is to drawn an overview for dynamical systems that can be described by scaling laws arguments and also interpret some of the phenomena that the non-linearity can bring to their dynamics. Very often these systems may present chaotic behavior in both dissipative and non-dissipative dynamics. In the non- dissipative case, a mixed phase space, with invariant tori, KAM islands and chaotic seas if often observed. Depending of the combination of control parameters and initial conditions, some variables of these systems can be described by scaling laws and classes of universality can be obtained. In the dissipative dynamics, chaotic attractors can lead the dynamics to different scenarios, where transients and assymptotic behavior of some variables can also be setup by scaling arguments. Also, self-similarity structures in the parameter space can be obtained and characterized by means of uncertainty exponents, and anomalous transport can be obrserved in different billiard systems.

MS-3: Dynamics and synchronization in complex networks

Rafael Soares Pinto[1]*, Tiago Pereira*[2]

[1]Universidade de São Paulo, São Carlos, Brazil, rsoaresp@gmail.com
[2]Universidade de São Paulo, São Carlos, Brazil, tiago@icmc.usp.br

Description : Complex behavior seen in nature arises from the coupling of many small and simple subsystems. To describe the topology of interactions, the machinery of complex network theory is often employed. The main purpose of this minisymposium is to bring together different people working on different dynamics, with special attention to synchronization phenomena, on complex networks, such that perspectives and experiences can be shared among the participants.

MS-4: Chaos-based communications and signal processing

Marcio Eisencraft[1]

[1]Escola Politécnica, University of São Paulo, São Paulo, Brazil, marcio@lcs.poli.usp.br

Description: In the last decades many possible applications of nonlinear dynamics in communication systems and signal processing have been reported. Conversely, techniques usually employed by the signal processing and communication systems community, as correlation, power spectral density analysis and linear filters, have been used to characterize chaotic dynamical systems. This minisymposium will present works that aim to use tools from both fields to generate new and interesting results.

MS-5: Computational Neuroscience

Leandro Alexandre da Silva[1] *and Rafael Dias Vilela*[1]

[1]Universidade Federal do ABC, Santo Andre, Brazil, {leandro.silva; rafael.vilela}@ufabc.edu.br

Description : Computational Neuroscience combines techniques from nonlinear and stochastic dynamics, information theory and other theoretical fields to offer both predictions to new phenomena and unifying, principle-unveiling explanations for known experimental results. This mini-symposium will address both individual and collective properties of neuronal dynamics.

MS-6: COMPLEX NETWORKS AS AN INTERDISCIPLINARY TOOL ON MEASUREMENT OF CRITICAL INFRASTRUCTURE'S VULNERABILITY AGAINST NATURAL DISASTERS

Leonardo B. L. Santos[1]

[1]Brazilian National Center for Monitoring and Early Warning of Natural Disasters (Cemaden/MCTI), São José dos Campos/SP, Brasil, santoslbl@gmail.com

Abstract: Natural disasters cause great human and material losses worldwide and its growing risk is a matter of global concern, especially with the prospects of increased frequency and intensity of extreme precipitation events. Structures such networks, with complex connections and interdependencies, permeate the research on Natural Disasters, from hydrography systems (threats) to critical infrastructure networks (impacts). Nonlinear Science and Complexity applications on natural disaster's researches are scientifically and socially relevant (http://oglobo.globo.com/sociedade/ciencia/a-matematica-na-prevencao-de-desastres-naturais-16981638).

MS-7: NONLINEAR DYNAMICS OF CONSERVATIVE AND DISSIPATIVE COMPLEX SYSTEMS

Organizer: Ricardo Luiz Viana[1]

[1] Departamento de Física, Universidade Federal do Paraná, Curitiba, PR, Brazil, viana@fisica.ufpr.br

Description : The main purpose of this minisymposium is to present recent developments in the nonlinear dynamics of conservative and dissipative complex systems, emphasizing applications in various fields like plasma physics, complex networks, turbulence and diffusion.

MS-8: Lie group analysis and its applications

Organizers: Maria Luz Gandarias[1], Maria Santos Bruzón[1] , Chaudry Masood Khalique[2]

[1] *Department of Mathematics, University of Cadiz, Puerto Real, Spain* , marialuz.gandarias@uca.es
[1] *Department of Mathematics, University of Cadiz, Puerto Real, Spain,* m.bruzon@uca.es
[2]*International Institute for Symmetry Analysis and Mathematical Modelling, Department of Mathematical Sciences, North-West University, Mafikeng Campus, Mmabatho, South Africa* Masood.Khalique@nwu.ac.zaa

Description : Several mathematical models that describe many phenomena in natural sciences, such as physics, biology, engineering, and economics can be modelled by nonlinear differential equations. However, it is difficult to obtain exact solutions of such nonlinear differential equations.

The Lie group analysis approach is considered to be a milestone in the search for solutions of nonlinear differential equations. In fact, although this approach is not always able to characterize the whole set of solutions, it allows one to get wide classes of exact solutions in a methodological way. Moreover the knowledge of symmetries admitted by an equation does not bring only to a reduction of independent variable but allows us to get conservation laws or to first integrals.

In the last few decades, a large amount of publications in theoretical and applied mathematics are devoted to the Lie group analysis methods and their applications.

The Lie group method specifies and extends the concept of symmetry, yields the effective methods of symmetry applications in complicated situations, gives correct statement of problems and in many cases indicates the possible way of their solutions.

The aim of this minisymposium is to focus the attention of scientists on symmetry methods to search for exact solutions of nonlinear models in physics, in engineering science, and in biology as well as to show recent developments of the theoretical tools of the Lie group methods applicable to the study of differential equations.

Contributive Technical Sessions

- TS-01 Nonlinear Dynamical Systems and Application - I
- TS-02 Celestial Mechanics and Dynamical Astronomy
- TS-03 Chaos and Global Phenomena - I
- TS-04 Chaos and Global Phenomena - II
- TS-05 Infinite Dimension Sytems, Pasma and Turbulence - I
- TS-06 Control in Chaos and Complex Systems
- TS-07 Biffurcation Theory and Applications - I
- TS-08 Synchronization and Complex Networks - I
- TS-09 Synchronization and Complex Networks - II
- TS-10 Nonlinear Dynamical Systems and Application - II
- TS-11 Modeling, Numerical Simulation and Optimization - I
- TS-12 Biffurcation Theory and Applications - II
- TS-13 Synchronization and Complex Networks - III
- TS-14 Modeling, Numerical Simulation and Optimization - II
- TS-15 Nonlinear Dynamical Systems and Application - III
- TS-16 Infinite Dimension Systems , Pasma and Turbulence - II

Program

May, 16th 2016 – Monday

8h00-8h30 – Registration

8h30-9h00 – Open Ceremony

9h00-10h30 – Parallel Sessions: Minisymposia and Contributive Sessions

MS-01 – Transient Chaos in Complex Systems I/II

Room: FM

Organizers: *Abraham Chian*, ITA, INPE & University of Adelaide, São Jose dos Campos & Adelaide, Brazil & Australia*; Erico Rempel*, ITA & INPE, São Jose dos Campos, Brazil; *and Miguel Sanjuán*, Universidad Rey Juan Carlos, Madrid, Spain.

- 9h00-9h30: **Boundary crisis and chaotic transient in a model of tumor growth**; *Miguel Sanjuán*, Universidad Rey Juan Carlos, Madrid, Spain.
- 10h00-10h30: **Transport Barriers In Bidimensional And Multidimensional Systems**; *Caroline Martins*, ITA, São Jose dos Campos, Brazil; *Marisa Roberto*, ITA, São Jose dos Campos, Brazil; *Iberê Caldas*, USP, São Paulo, Brazil.

MS-02 – Chaos, Scalling Laws and Dynamical Systems – I/II

Room: RH

Organizer: *André Luis Prando Livorati*, Departamento de Física – UNESP Rio Claro-SP, Brazil.

- 9h00-9h30: **A dynamical phase transition for a family of Hamiltonian mappings: a phenomenological investigation to obtain the critical exponents**; *Edson Denis Leonel*, Departamento de Física – UNESP Rio Claro -SP, Brazil;
- 9h30-10h00: **Chaotic dynamics in an elliptical billiard with soft walls**; *Tiago Kroetz*, Universidade Tecnológica Federal do Paraná, Pato Branco-PR, Brazil;
- 10h00-10h30: **Stickiness influence in a driven stadium-like billiard: An ensemble separation mechanism;** *André Luis Prando Livorati,* Departamento de Física- UNESP, Rio Claro-SP, Brazil.

TS-01 – Nonlinear Dynamical Systems and Application – I

Room: S1

Chair: *Thiago Prado*, INPE, Sao Jose dos Campos, Brazil

- 9h20-9h40: TS-01-2 - **Variational iteration method in the time fractional Burgers equation;** *Adrian R. Gómez*, Military University New Granada, Colombia; *Edmundo Capelas de Oliveira*, UNICAMP, Brazil.
- 9h40-10h00: TS-01-3 – **Nonlinear Dynamics of an Origami Structure Coupled to Smart Materials**; *Larissa Fonseca,* Federal University of Rio de Janeiro, Brazil; *Guilherme Vieira*, UFRJ, Brazil; *Marcelo Savi*, UFRJ, Brazil; *Alberto Paiva*, UFF, Brazil.
- 10h00-10h20: TS-01-4 -**The postgraduate Brazilian studies in Physics Teaching using Complex Network**; *Jefferson Nascimento,* SENAI CIMATEC, Brazil; *Camila de Sousa Pereira Guizzo*, SENAI CIMATEC, Brazil; *Roberto Monteiro*, FIB, Brazil; *Davidson Moreira*, UFES, Brazil; *Marcelo Moret*, SENAI CIMATEC, Brazil; *Hernane Pereira*, SENAI CIMATEC, Brazil

10h30-10h45 – Coffee-Break

10h45-12:15 – Plenary Talks

Room: FM

- 10h45-11h30: P-01 – ***Jason Gallas**,* Universidade Federal da Paraíba-PB, Brazil;
  Periodicity and chaos: How are they organized in lasers, circuits, biochemical oscillators and other complex flows?
- 11h30-12h15: P-02 – **Christian Bick**, University of Exeter, Exeter, United Kingdom;
  Dynamics of Phase Oscillators with Generalized Coupling

12h15-13h30 – Lunch

13h30-15h30 – Parallel Sessions: Minisymposia and Contributive Sessions

MS-01 – Transient Chaos in Complex Systems II/II

Room: FM

Organizers: *Abraham Chian*, ITA, INPE & University of Adelaide, São Jose dos Campos & Adelaide, Brazil & Australia*; Erico Rempel*, ITA & INPE, São Jose dos Campos, Brazil; *and Miguel Sanjuán*, Universidad Rey Juan Carlos, Madrid, Spain.

- 13h30-14h00: **Route to hyperchaos and intermittency in Rayleigh-Bernard Convection**; *E.V. Chimanski*, ITA, São Jose dos Campos, Brazil; *R. Chertovskih*, ITA, São José dos Campos, Brazil; *Erico Rempel*, ITA & INPE, São Jose dos Campos, Brazil.

- 14h00-14h30: **Edge of chaos and genesis of turbulence**; *Abraham Chian*, ITA, INPE & University of Adelaide, São Jose dos Campos & Adelaide, Brazil & Australia; *Pablo Munoz,* Universidad de La Serena, La Serena, Chile; *Erico Rempel*, ITA & INPE, São José dos Campos, Brazil.
- 14h30-15h00: **Supertransient and amplitude-phase synchronization in astrophysical shear flows**; *Erico Rempel*, ITA & INPE, São Jose dos Campos, Brazil; *Rodrigo Miranda,* Faculdade Gama, Universidade de Brasilia (UnB), Brasilia, Brazil; *Abraham Chian*, ITA, INPE & University of Adelaide, São Jose dos Campos & Adelaide, Brazil & Australia;

MS-02 – Chaos, Scalling Laws and Dynamical Systems – II/II

Room: S1

Organizer: *André Luis Prando Livorati*, Departamento de Física – UNESP Rio Claro -SP, Brazil.

- 13h30-14h00: **Sensitive Dependence on Parameters of Continuous-time Nonlinear Dynamical Systems**; *Everton Medeiros*, Instituto de Física – USP, São Paulo-SP, Brazil; *Iberê Luis Caldas*, Instituto de Física – USP, São Paulo-SP, Brazil; *Murilo S. Baptista*, University of Aberdeen, ICSMB, Aberdeen, Scotland.
- 14h00-14h30: **Scaling laws and critical exponents in discrete mappings**; *Juliano Antônio de Oliveira*, Universidade Estadual Paulista-UNESP, São João da Boa Vista-SP, Brazil.
- 14h30-15h00: **Chaotic Explosions;** *Eduardo G. Altmann*, Max Planck Institute of Physics of Complex Systems, Dresden, Germany; *Jefferson Stafusa Elias Portela*, Universidade Tecnológica Federal do Paraná, Pato Branco-PR, Brazil; *Tamás Tél*, Eötvös Loránd University, Budapest, Hungary

TS-02 – Celestial Mechanics and Dynamical Astronomy

Room: RH

Chair: Othon Winter, UNESP, Guaratinguetá, Brazil

- 13h30-13h50: TS-02-1 - **The influences of the companion for the formation of the Gamma-Cephei planetary system;** *Ricardo Moraes*, UNESP, Brazil; *Ernesto Vieira Neto*, UNESP, Brazil.
- 13h50-14h10: TS-02-2 - **A Firefly Planetary Ring**; *Othon Winter*, UNESP, Brazil; *Alexandre Souza*, UNESP, Brazil; *Rafael Sfair*, UNESP, Brazil; *Silvia Giuliatti Winter*, UNESP, Brazil; *Decio Mourão*, UNESP, Brazil; *Dietmar Foryta*, UFPR, Brazil.
- 14h10-14h30: TS-02-3 – **Different population of hypothetical objects in the Pluto system and the New Horizons mission**, *Silvia M. Giuliatti Winter*, UNESP, Brazil.
- 14h30-14h50: TS-02-4 – **On the oldest asteroid families in the main belt**; *Valerio Carruba*, UNESP, Brazil; *David Nesvorný*, Southwest Research Institute, USA; *Safwan Aljbaae*, UNESP, Brazil; *Rita Domingos*, UNESP, Brazil; *Mariela Huaman*, UNESP, Brazil.
- 14h50-15h10: TS-02-5 – **On the Karin family**; *Valerio Carruba*, UNESP, Brazil; *David Nesvorný*, Southwest Research Institute, USA.

- 15h10-15h30: TS-02-6 – **Lags of Prometheus and Pandora**; *Thamiris de Santana*, UNESP, Brazil; *Othon Winter*, UNESP, Brazil; *Decio Mourão*, UNESP. Brazil;

15h30-15h45 – Coffee-Break

15h45-16:30 – Plenary Talks

Room: FM

- 15h45-16h30: P-03 – ***Mark Edelman***, Stern College at Yeshiva University, New York, USA;
  Systems with power-law memory and fractional dynamics

16h30-18h30 – Parallel Sessions: Minisymposia and Contributive Sessions

MS-03 – Dynamics and synchronization in complex networks I/III

Room: FM

Organizers: *Rafael Soares Pinto*, USP, São Carlos, Brazil *and Tiago Pereira*, USP, São Carlos, Brazil.

- 16h30-17h00: **Synchrony patterns on gradient networks**; *Miriam Manoel*, Departamento de Física, ICMC – USP São Carlos-SP, Brazil; *M. Roberts*, Department of Mathematics, University of Surrey, Guildford, United Kingdom;
- 17h00-17h30: **Robust heteroclinic networks in coupled identical cell networks: Realization and patterns of synchronization**; *Mike J Field*, Department of Mathematics – Imperial College, London, United Kingdom & Rice University, Houston-TX, USA;
- 17h30-18h00: **Effects of synaptic plasticity on the synchronisation in neural network;** P. R. Protachevicz, *R. C. Bonetti, F. S. Borges, R. R. Borges, K. C. Iarosz, A. M. Batista*, Universidade Estadual de Ponta Grossa - Setor de Ciências Exatas, Ponta Grossa – PR, Brazil.
- 18h00-18h30: **Squared sine logistic map**; *R. Egydio de Carvalho*, UNESP, Rio Claro-SP, Brazil; *Edson D. Leonel*, Departamento de Física - UNESP, Rio Claro-SP, Brazil;

MS-04 – Chaos-based communications and signal processing – I/II

Room: RH

Organizer: *Marcio Eisencraft*, Escola Politécnica - USP, São Paulo-SP, Brazil

- 16h30-17h00: **Chaotic Map Sequence as Fingerprint for Physical Authentication System**; *Joao V. C. Evangelista, Daniel Chaves, Cecilio Pimentel,* Universidade Federal de Pernambuco, Recife, Brazil;

- 17h00-17h30: **Spectral Properties of the Orbits of the Hénon map**; *Rafael Costa* & *Marcio Eisencraft,* Escola Politécnica, University of São Paulo, São Paulo, Brazil;
- 17h30-18h00: **White Gaussian Chaos;** *Marcio Eisencraft*, Escola Politécnica - USP, São Paulo-SP, Brazil.

TS-03 – Chaos and Global Phenomena – I

Room: S1
Chair: *Antônio Marcos Batista*, Universidade Estatudal de Ponta Grossa, Brazil

- 16h30-16h50: TS-03-1 - **Complexity Metric Applied to the Discrete Events Systems**; *João Paiva*, UFG, Brazil; Viviane Gomes, IFG, Brazil; *Bruno Aniceto*, UFG, Brazil; *Geovanne Furrie*l, UFG, Brazil; *Lais Fernanda*, UFG, Brazil; *Wesley Calixto*, UFG, Brazil.
- 16h50-17h10: TS-03-2 - **First return times to approximated generating partitions of induced Duffing map**; *Rodrigo Pereira*, UTFPR, Brazil.
- 17h10-17h30: TS-03-3 – **Numerical Imprecision and its Impact on Discrete Systems as Logistic Map**; *Bruno Ossalin Paiva,* Universidade Federal de São João del Rei, Brazil; *Erivelton Geraldo Nepomuceno*, UFSJ, Brazil; *Gleison Amaral*, UFSJ, Brazil.
- 17h30-17h50: TS-03-4 – **Anomalous sea surface structures (rogue waves) as an object of statistical topography**; *Valeriy Klyatskin*, Obukhov Atmospheric Physics Institute of RAS, Russia; *Konstantin Koshel*, Pacific Oceanological Institute, Russia.
- 17h50-18h10: TS-03-5 – **Effect of the turbulent diffusion on passive scalar transport induced by an isolated vortex model**; *Konstantin Koshel*, Pacific Oceanological Institute, Russia; *Eugeny Ryzhov*, Pacific Oceanological Institute, Russia; *Vladimir Zhmur*, Institute of Oceanology of RAS, Russia.
- 18h10-18h30: TS-03-6 – **Nonlinear free vibrations of shear deformable beams with axially movable boundary conditions**; *Francesco Clementi*, Polytechnic University of Marche, Italy; *Stefano Lenci*, Polytechnic University of Marche, Italy; *Giuseppe Rega*, Sapienza University of Rome, Italy.

May, 17th 2016 – Tuesday

8h30-10h30 – Parallel Sessions: Minisymposia and Contributive Sessions

MS-03 – Dynamics and synchronization in complex networks II/III

Room: FM
Organizers: *Rafael Soares Pinto*, USP, São Carlos, Brazil *and Tiago Pereira*, USP, São Carlos, Brazil

- 8h30-9h00: **Synchronization and Applications**; *Hildebrando M. Rodrigues*, Departamento de Matemática Aplicada e Estatística, ICMC-USP, São Carlos-SP, Brazil;
- 9h00-9h30: **Connectivity-Driven Coherence in Complex Networks;** *Deniz Eroglu*, *Tiago Pereira*, Institute of Mathematical and Computer Sciences, USP, São Carlos, Brazil.
- 9h30-10h00: **Using neuroimaging techniques to reveal the brain complex networks at rest**; *R.C. Mesquita*, S.L. Novi, Instituto de Física, UNICAMP, Campinas-SP, Brazil; R.F. Casseb, Faculdade de Ciências Médicas, UNICAMP, Campinas-SP, Brazil; G. Castellano, Instituto de Física, UNICAMP, Campinas-SP, Brazil;
- 10h00-10h30: **Collective dynamics in two populations of noisy oscillators with asymmetric interactions**; *Thomas Kauê Dal'Maso* Peron, ICMC-USP, São Carlos-SP, Brazil; Francisco *Rodrigues*, ICMC-USP, São Carlos-SP, Brazil;

MS-04 – Chaos-based communications and signal processing – II/II

Room: RH

Organizer: *Marcio Eisencraft*, Escola Politécnica - USP, São Paulo-SP, Brazil

- 8h30-9h00: **Chaotic Properties of the Hénon Map with a linear filter**; *Rodrigo T. Fontes* & *Marcio Eisencraft,* Escola Politécnica - USP, São Paulo-SP, Brazil;
- 9h00-09h30: **IIR Equalization Based on Complexity Measures in the Context of Chaotic Information Sources**; *Patrick F. Coutinho, DCA/FEEC/UNICAMP, Campinas, Brazil, Diogo C. Soriano*, CECS/UFABC, Santo André, Brazil, *Filipe Ieda Fazanaro,* CECS/UFABC, Santo André, Brazil, *Romis Attux,* DCA/FEEC/UNICAMP, Campinas, Brazil*;*
- 09h30-10h00: **A Switching Scheme Between Conventional and Chaos-based Communication Systems;** *Renato Candido*, *Magno T. M. Silva & Marcio Eisencraft,* Escola Politécnica - USP, São Paulo-SP, Brazil.

TS-04 – Chaos and Global Phenomena – II

Room: S1

Chair: *Iberê Luiz Caldas*, IF, USP, São Paulo, Brazil

- 8h30-8h50: TS-04-1 - **A Dynamical Approach to Time Series with Fluctuating Statistical Parameters;** *Ivan Roa Gonzalez*, UFPE, Brazil; *Giovani Lopes Vasconcelos*, UFPE, Brazil; *Antonio Murilo Macedo*, UFPE, Brazil.
- 8h50-9h10: TS-04-2 - **Spectral properties of temporal evolution of brain network structure**; *Rong Wang*, Xi'an Jiaotong University, P. R. China; *Pan Lin*, Xi'an Jiaotong University, P. R. China; *Ying Wu*, Xi'an Jiaotong University, P. R. China.
- 9h10-9h30: TS-04-3 – **Dynamical potentials for non-equilibrium stationary states driven by multiplicative stochastic processes**;

Daniel Barci, University of the State of Rio do Janeiro, Brazil; *Miguel Moreno*, UERJ, Brazil; *Zochil González Arenas*, UERJ; Brazil.

- 9h30-9h50: TS-04-4 – **Detecting dynamical changes in data streams**; *Fausto Guzzo da Costa*, USP, Brazil; *Rodrigo Mello*, USP, Brazil.
- 9h50-10h10: TS-04-5 – **Set Stability of Fixed Points for Discrete Maps**; *Bruno Ossalin Paiva*, Universidade Federal de São João del Rei, Brazil; *Erivelton Geraldo Nepomuceno*, UFSJ, Brazil; *Gleison Amaral*, UFSJ, Brazil.

10h30-10h45 – Coffee-Break

10h45-12h15 – Plenary Talks

Room: FM

- 10h45-11h30: P-04 – ***Miguel Sanjuán**,* King Juan Carlos University, Mósteles, Madrid, Spain;
  Basin Entropy: A new tool to explore uncertainty in dynamical systems.
- 11h30-12h15: P-05 - ***Lev A. Ostrovsky***, National Oceanic and Atmospheric Administration (NOA), Boulder, CO, USA;
  Acoustic radiation force, dynamics of particles and bubbles in acoustic field, and biomedical applications.

12h15-13h30 – Lunch

13h30-15h30 – Poster Session I

15h30-15h45 – Coffee-Break

15h45-16:30 – Plenary Talks

Room: FM

- 15h45-16h30: P-06 – ***José Roberto Castilho Piqueira***, Escola Politécnica, USP, Brazil;
  Hopf bifurcation and chaos in a third-order phase-locked loop

16h30-18h30 – Parallel Sessions: Minisymposia and Contributive Sessions

MS-03 – Dynamics and synchronization in complex networks – III/III

Room: FM
Organizers: *Rafael Soares Pinto*, USP, São Carlos, Brazil *and Tiago Pereira*, USP, São Carlos, Brazil

- 16h30-17h00: **Hidden symmetries in coupled cell network vector fields;** *Eddie Nijholt*, Department of Mathematics, VU University Amsterdam, The Netherlands;
- 17h00-17h30: **Dynamics of phase oscillator populations with heterogeneous phase lags**; *Christian Bick*, College of Engineering, Mathematics and Physical Sciences University of Exeter, Exeter, United Kingdom;
- 17h30-18h00: **Chimera states from explosive synchronization,** *Rafael Soares Pinto*, Tiago Pereira & Jaap Eldering, ICMC-USP, São Carlos-SP, Brazil;
- 18h00-18h30: **Stochastic Quasispecies Model: Form Self-Replicating Polynucleotides to RNA viruses;** *Fernando Antoneli*, Laboratório de Genômica Evolutiva e Biocomplexidade & DIS Escola Paulista de Medicina – Unifesp, São Paulo-SP, Brazil.

MS-05 – Computational Neuroscience

Room: RH
Organizers: *Leandro Alexandre da Silva*[1] *& Rafael Dias Vilela*[1]
[1]UFABC, Santo André -SP, Brazil.

- 16h30-17h00: **Collective Dynamics suppresses Fluctuations**; *Tiago Pereira da Silva*, USP, São Carlos-SP, Brazil;
- 17h00-17h30: **Conditional Lyapunov Exponents for Izhikevich Neuronal Model**; *Filipe I. Fazanaro, Ricardo Suyama & Diogo Soriano,* CECS/UFABC, Santo André-SP, Brazil;
- 17h30-18h00: **Colored noise and memory effects on formal spiking neuron models;** *Leandro Alexandre da Silva & Rafael Dias Vilela*, UFABC, Santo André-SP, Brazil;
- 18h00-18h30: **On the beneficial role of memory for signal detection by threshold systems**; *Leandro Alexandre da Silva & Rafael Dias Vilela*, UFABC, Santo André-SP, Brazil;

TS-06 – Control in Chaos and Complex Systems

Room: S1
Chair: Leonardo Santos, CEMADEN, São José dos Campos, SP

- 16h30-16h50: TS-06-1 - **Supernovae Automatic Classification Method by Modeling Human Analysis using Artificial Neural Networks**; *Marcelo Módolo,* INPE, Brazil; *Lamartine Nogueira Frutuoso Guimarães*, IEAv, Brazil; *Reinaldo Rosa*, INPE, Brazil.

- 16h50-17h10: TS-06-2 - **Reactive model for convergence of active agents to moving formations**; *Vander Freitas*, INPE, Brazil; *Elbert E. N. Macau*, INPE, Brazil.
- 17h10-17h30: TS-06-3 – **Complexity Reduction for An Optimal Stopping Problem: A Two-Time-Scale Approach**; *Qing Zhang,* University of Georgia, USA; *George Yin*, Wayne State University, USA.
- 17h30-17h50: TS-06-4 – **Modeling the atmospheric turbulence with intermittency**; *Haroldo Campos Velho*, INPE, Brazil; *Reinaldo Rosa*, INPE, Brazil; *Fernando Ramos*, INPE, Brazil; *Roger Pielke Sr.*, CIRES, USA.
- 17h50-18h10: TS-06-5 – **Nonlinear suboptimal controller design for chaotic motions of mobile robot formations**; *Elvira Rafikova*, UFABC, Brazil; *Marat Rafikov*, UFABC, Brazil; *Guilherme Rinaldo*, UFABC, Brazil.

May, 18th 2016, Wednesday

8h30-10h30 – Parallel Sessions: Minisymposia and Contributive Sessions

MS-06 – Complex Networks as an Interdisciplinary Tool on Measurement of Critical Infrastructure's Vulnerability Against Natural Disasters – I/II

Room: FM
Organizer: *Leonardo B. L. Santos*, Cemaden/MCTI, São José dos Campos -SP, Brazil;

- 8h30-9h00: **Conceptual Interfaces Between The Natural Disaster Terminology And Complex Systems Theory**; *Luciana R. Londe & Leonardo B. L. Santos,* CEMADEN, São José dos Campos-SP, Brazil;
- 9h00-9h30: **Pghydro – Hydrographic Objects In Spatial Database Management System**; *Alexandre A. Teixeira*, National Agency of Water-ANA, Brasília-DF, Brazil;
- 9h30-10h00: **Weather Radar Forecasting For Natural Disasters Early Warning At The Scale Of Susceptibility Areas;** *Tiago Carvalho*, *Marcos L. Rodrigues & Jojhy Sakuragi,* CEMADEN, São José dos Campos-SP, Brazil;

TS-07 – Bifurcation Theory and Applications – I

Room: RH
Chair: *Tiago Pereira*, USP, São Carlos, Brazil

- 8h30-8h50: TS-07-1 - **Asymptotic analysis of the everted state of circular cylindrical shell;** *Leonid Srubshchik*, Cooper Union College, USA.
- 8h50-9h10: TS-07-2 - **Stochastic dynamics with multiplicative noise: An analysis on time reversibility**; *Zochil González Arenas*, University of the State of Rio de Janeiro, Brazil; Daniel Barci, UERJ, Brazil.
- 9h10-9h30: TS-07-3 – **Bifurcation and Shock Wave Solutions of Burgers Equation**; *Chunqing Lu,* Southern Illinois University Edwardsville, USA.

- 9h30-9h50: TS-07-4 – **Analytical bifurcation trees of periodic motions to chaos in a periodically driven pendulum**; *Albert Luo*, Southern Illinois University Edwardsville, USA; Yu Guo, Midwestern State University, USA.
- 9h50-10h10: TS-07-5 – **Dynamics and indirect nite-time stability of modi ed relay-coupled chaotic systems**; *Patrick Herve Louodop* , UNESP, Brazil; Hilda Cerdeira, UNESP, Brazil.
- 10h10-10h30: TS-07-6 – **Devil's Staircase in an Optomechanical Cavity**; *Eyal Buks*, Technion, Israel.

TS-08 – Synchronization and Complex Networks - I

Room: S1
Chair: *Marcos Quiles*, UNIFESP, São José dos Campos, Brazil

- 8h30-8h50: TS-08-1 - **Price-setting mixed triopolies**; *Fernanda Ferreira*, Polytechnic of Porto, Portugal; *Flávio Ferreira*, Polytechnic of Porto, Portugal.
- 8h50-9h10: TS-08-2 - **Monitoring of Waste Generated in the Classroom of Uninorte rooms through sensors Ultrasonic and CO^2 in the Recycle Bins**; *Eucriney Albuquerque de Melo*, Centro Universitário do Norte, Brazil;
- 9h10-9h30: TS-08-3 – **Using neuroimaging techniques to reveal the brain complex networks at rest**; *Rickson Coelho Mesquita,* UNICAMP, Brazil; *Sergio Novi Junior*, UNICAMP, Brazil.
- 9h30-9h50: TS-08-4 – **Frequency synchronization in power-grid models of Kuramoto-like model**; *José Mario Vicensi Grzybowski*, Federal University of Fronteira Sul, Brazil; *Elbert E. N. Macau*, INPE, Brazil; *Takashi Yoneyama*, ITA, Brazil.
- 9h50-10h10: TS-08-5 – **Privatization and government preference in a Bertrand model**; *Fernanda Ferreira*, Polytechnic of Porto, Portugal; *Flávio Ferreira*, Polytechnic of Porto, Portugal.

10h30-10h45 – Coffee-Break

10h45-12:15 – Plenary Talks

Room: FM

- 10h45-11h30: P-07 – ***Martin Mönnigman***, Ruhr-Universität Bochum, Germany;
  Constructive Nonlinear Dynamics: Integrating Applied Bifurcation Theory with Optimization.
- 11h30-12h15: P-08 – ***Lea F. Santos***, Yeshiva University, New York, USA;
  Powerlaw Decays and Thermalization in Chaotic Quantum Systems.

12h15-13h30 – Lunch

May, 19th 2016 – Thursday

8h30-10h30 – Parallel Sessions: Minisymposia and Contributive Sessions

MS-06 – Complex Networks as an Interdisciplinary Tool on Measurement of Critical Infrastructure's Vulnerability Against Natural Disasters – II/II

Room: FM
Organizer: *Leonardo B. L. Santos*, Cemaden/MCTI, São José dos Campos -SP, Brazil;

- 8h30-9h00: **Survivability Evaluation Of Critical Infrastructures** *Daniel S. Menasche*, UFRJ, Rio de Janeiro-RJ, Brazil;
- 9h00-9h30: **Complex Networks In Geographical Information Systems - Crossing Hydrography And Transportation Networks**; *Leonardo B. L. Santos*, *Aurelienne A. Souza Jorge & Beatriz M. M. Silva*, CEMADEN, São José dos Campos-SP, Brazil; *Alessandro C. Miola*, UFSM, Santa Maria-RS, Brazil;

MS-07 – Nonlinear Dynamics Of Conservative And Dissipative Complex Systems – I/II

Room: RH
Organizer: *Ricardo Luiz Viana*, Departamento de Física, Universidade Federal do Paraná, Curitiba-PR, Brazil.

- 8h30-9h00: **Analysis of Plasma Turbulence in Texas Helimak**; *D. L. Toufen*, Federal Institute of Education, Science and Technology of São Paulo, Guarulhos-SP, Brazil; *F. A. Pereira, Z. O. Guimarães-Filho & I. L. Caldas,* Instituto de Física - USP, São Paulo-SP, Brazil; *K. W. Gentle,* Department of Physics and Institute for Fusion Studies, The University of Texas at Austin, Austin-TX, USA.
- 9h00-9h30: **Community detection in complex networks via dynamics**; *Elbert E. N. Macau*, INPE, São José dos Campos-SP, Brazil;
- 9h30-10h00: **Synchronization of nonlinear phase oscillators with coupling mediated by a diffusing substance;** *Carlos Adalberto Schnaider Batista*, UFPR, Pontal do Paraná-PR, Brazil; *José Danilo Szezech Jr. & Antônio Marcos Batista,* UEPG, Ponta Grossa-PR, Brazil; *Elbert E. Nehrer Macau,* INPE, São José dos Campos-SP, Brazil; *Sérgio Roberto Lopes & Ricardo Luiz Viana*, UFPR, Curitiba-PR, Brazil;
- 10h00-10h30: **Control of anomalous transport and stickiness in Hamiltonian systems**; *Taline Suellen Krüger*, *Paulo Paneque Galuzio*, *Thiago de Lima Prado & Ricardo Luiz Viana,* UFPR, Curitiba-PR, Brazil; *José Danilo Szezech Jr.,* UEPG, Ponta Grossa-PR, Brazil; *Sergio Roberto Lopes*, UFPR, Curitiba-PR, Brazil;

TS-05 – Infinite Dimension Systems, Plasma and Turbulence – I

Room: S1

Chair: *Reinaldo Roberto Rosa*, INPE, São José dos Campos, Brazil

- 08h30-08h50: TS-05-1 - **3DBMO: A Time Series Canonical Generator to Study the PSD Dimensional Dependence in Complex Physical Systems;** *Paulo Zeferino*, INPE, Brazil; *Reinaldo Rosa*, INPE, Brazil; *Murilo Dantas*, IFSP, Brazil.
- 08h50-08h10: TS-05-2 – **Perturbative methods in agent based epidemic models**; *Alexandre Martinez,* USP, Brazil; *Gilberto Nakamura*, USP, Brazil.
- 08h10-08h30: TS-05-3 – **High-Order Numerical Approach for Computational Model of the Pressureless Gas Dynamics Equations**; *SungKi Jung,* UFABC, Brazil.
- 08h30-08h50: TS-05-4 – **Scattering theory of walking droplets in the presence of obstacles**; *Remy Dubertrand*, University of Liege, Belgium.
- 08h50-08h10: TS-05-5 – **Discrete Elements on Paralell Multi-core Using Dynamic Particle Flow Simulations to Examine Fresh Concrete and Slump Test Parameters**; *Luiz Carlos Sanches*, UNESP, Brazil.
- 08h10-08h30: TS-05-6 – **Simulating the interaction of a comet with the solar wind using a magnetohydrodynamic model**; *Edgard de Freitas Diniz Evangelista*, INPE, Brazil; *Margarete Domingues*, INPE, Brazil; *Odim Mendes*, INPE, Brazil; *Oswaldo Duarte Miranda*, INPE, Brazil.

10h30-10h45 – Coffee-Break

10h45-12:15 – Plenary Talks

Room: FM

- 10h45-11h30: P-09 – ***Luis Fernando Costa Alberto***, USP de São Carlos, Brazil;
  Avoiding Blackouts with Theory of Stability Regions.
- 11h30-12h15: P-10 – ***J. A. Tenreiro Machado***, Politécnica do Porto, Porto, Portugal;
  Fractional calculus and applications

12h15-13h30 – Lunch

13h30-15h30 – Poster Session II

15h30-15h45 – Coffee-Break

15h45-16:30 – Plenary Talks

Room: FM

- 15h45-16h30: P-11 – ***J. M. Martínez**,* IMECC, UNICAMP, Brazil; Complexity in Unconstrained and Constrained Optimization.

Room: RH

- 15h45-16h30: P-12 – **Matteo Tanzi**, Imperial College, London, UK; Expanding Dynamics on Heterogeneous Networks: Mean Field Reduction and Synchronisation.

16h30-18h30 – Parallel Sessions: Minisymposia and Contributive Sessions

MS-08 – Lie group analysis and its applications

Room: U

Organizer: *Maria Luz Gandarias*[1], *Maria Santos Bruzón*[1] & *Chaudry Masood Khalique*[2],
[1]Department of Mathematics, University of Cadiz, Puerto Real, Spain
[2]Department of Mathematical Sciences, North-West University, Mafikeng Campus, Mmabatho, South Africa

- 16h30-17h00: **Some Conservation laws of a Boussinesq equation with strong internal damping**; *Maria Luz Gandarias* & *Maria Rosa*, University of Cadiz, Spain;
- 17h00-17h30: **Nonlinear Self-Adjointness And Conservation Laws Of A Generalized Benjamin-Bona-Mahony-Burgers Equation**; *M.S. Bruzón, T. Garrido & R. de la Rosa*, University of Cádiz, Puerto Real, Spain;
- 17h30-18h00: **Solutions and conservation laws of a class of nonlinear dispersive wave equations;** *Chaudry Masood Khalique*, North-West University, Mafikeng Campus, Mmabatho, South Africa;
- 18h00-18h30: **An optimal system and group-invariant solutions of the Vasicek pricing equation of mathematical finance**; *Tanki Motsepa*, North-West University, Mafikeng Campus, Mmabatho, South Africa;

TS-09 – Synchronization and Complex Networks – II

Room: S1

Chair: *Ricardo Viana*, UFPR, Curitiba, Brazil

- 16h30-16h50: TS-09-1 - **Lyapunov spectrum of chaotic maps with a coupling mediated by a diffusing substance**; *Ricardo Viana,* UFPR, Brazil; *Carlos Batista*, UEPG, Brazil; *Antonio Batista*, UEPG, Brazil; *Kelly Iarosz*, USP, Brazil.
- 16h50-17h10: TS-09-2 - **Hurst exponent estimation of self-affine time series through a complex network approach**; *Andriana Campanharo*, UNESP, Brazil; *Fernando Ramos*, INPE, Brazil.
- 17h10-17h30: TS-09-3 – **On the Fundamental Characteristics of Complex Network with Multi-Agent Constituents**; *Chun-Lin Yang,* Texas A&M University, USA; *C. Steve Suh*, Texas A&M University, USA.
- 17h30-17h50: TS-09-4 - **The influence of hubs in the structure of a neuronal network during an epileptic seizure**; *Abner Rodrigues*, USP, Brazil; *Hilda Cerdeira*, UNESP, Brazil; *Birajara Machado*, Hospital Israelita Albert Einstein, Brazil.
- 17h50-18h10: TS-09-5 – **Complex Network Into Geographical Information Systems;** *Beatriz da Silva*, FATEC, Brazil; *Lucas Valerio*, UNESP, Brazil; *Maria Jurema*, UNESP, Brazil; *Leonardo Santos*, CEMADEN-MCTI, Brazil.
- 17h10-18h30: TS-09-6 – **A geographically-aware complex network approach for foot-and-mouth disease phylodynamics**; *Luiz Max F. de Carvalho,* University of Edinburgh, United Kingdom; *Leonardo Santos*, CEMADEN-MCTI, Brazil; *Paulo E. P. Burke*, UNIFESP, Brazil; *Marcos Quiles*, UNIFESP, Brazil; *Waldemir de Castro Silveira*, Trimatrix LTDA, Brazil.

TS-10 – Nonlinear Dynamical Systems and Application – II

Room: RH

Chair: *Kelly Cristiane Iarosz*, USP, São Paulo, Brazil

- 16h30-16h50: TS-10-1 - **Charge Behavior Analysis In Ball Mills By Using Torque Signal - An Alternative To Increase The Efficiency Of Ball Mills;** *Luiz Carlos Silva*, UFABC, Brazil; *Jesus Franklin Andrade Romero*, UFABC, Brazil; *Gustavo Taets Nascimento*, UFABC, Brazil; *Thiago de Oliveira Pistola*, UFABC, Brazil.
- 16h50-17h10: TS-10-3 – **Nonlinear damping in MEMS/NEMS beam resonators resulting from clamping loss**; *Andre Gusso,* UFF, Brazil; *Jéssica Pimentel*, UFF, Brazil.
- 17h10-17h30: TS-10-4 – **Investigating the helicopter dynamics by bred vector**; *Ivana Sumida*, INPE, Brazil; *Thiago Ritto*, UFRJ, Brazil; *Haroldo Campos Velho*, INPE, Brazil.
- 17h30-17h50: TS-10-5 – **Invariant solutions of (2+1) dimensional modified dispersive water wave system**; *Sachin Kumar*, Central University of Punjab, India.
- 17h50-18h10: TS-10-6 – **Estimation of pitch period in voice signals using Poincaré section**; *Fernando Sobrinho*, Instituto Federal do Sul de Minas, Brazil; *Maria Dajer*, UTFPR, Brazil; *Luis Alberto*, USP, Brazil.

TS-11 – Modeling, Numerical Simulation and Optimization – I

Room: S1

Chair: *José Tenreiro Machado*, Polytechnic of Porto, Portugal.

- 16h30-16h50: TS-11-1 - **Multiobjective optimization application in DOE problems with multiple responses;** *Douglas Rodrigues*, INPE, Brazil; *Aneirson Silva*, UNESP, Brazil; *Fernando Augusto Marins*, UNESP, Brazil; *Rafael de Carvalho Miranda*, UNIFEI, Brazil; *Erica Dias*, UNESP, Brazil; *José Roberto D. Luche*, UNESP, Brazil.
- 16h50-17h10: TS-11-2 - **A delayed p53 ubiquitination induced via c-Myc-ARF interaction pathway**; *Md Jahoor Alam*, University of Hail, Kingdom of Saudi Arabia.
- 17h10-17h30: TS-11-3 – **Excitatory and Inhibitory Synapses in Coupled Model Neurons**; *Epaminondas Rosa,* Illinois State University, USA, *Rosangela Follmann*, Illinois State University, USA.
- 17h30-17h50: TS-11-4 – **Uncertainty Analysis of Smart Composite Materials**; *Fabian Andres Lara Molina*, Federal Technological University of Paraná, Brazil; *Edson Hideki Koroishi*, UTFPR, Brazil; *Albert Willian Faria*, UFTM, Brazil.
- 17h50-18h10: TS-11-5 – **Fractional-Order Models for Vegetable Tissues**; *José Tenreiro Machado*, Polytechnic of Porto, Portugal; *Antonio Lopes*, Universidade do Porto, Portugal.
- 18h10-18h30: TS-11-6 – **Parametric excitation of offshore riser using reduced-order models based on Bessel-type modes: calibration of hydrodynamic coefficients**; *Guilherme Franzini*, USP, Brazil; *Thiago Dias*, USP, Brazil; *Carlos Mazzilli*, USP, Brazil; *Celso Pesce*, USP, Brazil.

May, 20th 2016 – Friday

8h30-10h30 – Parallel Sessions: Minisymposia and Contributive Sessions

MS-07 – Nonlinear Dynamics Of Conservative And Dissipative Complex Systems

Room: FM

Organizer: *Ricardo Luiz Viana*, Departamento de Física, Universidade Federal do Paraná, Curitiba-PR, Brazil.

- 8h30-9h00: **Escape time and transport in E x B drift motion;** *R. S. Oyarzabal*, *J. D. Szezech Jr,* Department of Physics-UEPG, Ponta Grossa-PR, Brazil; *A. M. Batista,* Department of Mathematics and Statistics-UEPG, Ponta Grossa-PR, Brazil; *S. L. T. de Souza,* UFSJ, Ouro Branco-MG, Brazil; *I. L. Caldas,* USP, São Paulo-SP, Brazil; *R. L. Viana,* UFPR, Curitiba-PR, Brazil; *M. A. F. Sanjuán,* Universidad Rey Juan Carlos, Móstoles, Madrid, Spain;
- 9h00-9h30: **Coexistent subharmonic resonant modes of a forced bilinear oscillator**; *Tiago Kroetz*, UTFPR, Pato Branco-PR, Brazil; *Ricardo Luiz Viana*, UFPR, Curitiba-PR, Brazil;

TS-12 – Bifurcation Theory and Applications – II

Room: RH
Chair: *Thiago Prado*, INPE, São José dos Campos, SP

- 8h30-8h50: TS-12-1 - **Analysis of a Temperature Dependent Multi Stable Pendulum System;** *Dimitri Costa*, UFRJ, Brazil; *Marcelo Savi*, UFRJ, Brazil.
- 8h50-9h10: TS-12-2 - **Conditional Lyapunov Exponents for Izhikevich Neuronal Model**; *Filipe Fazanaro*, UFABC, Brazil; *Ricardo Suyama*, UFABC, Brazil; Diogo Soriano, UFABC, Brazil.
- 9h10-9h30: TS-12-3 **– Eigenvalue analysis of a simple flexible rotor**; *Renan Correa,* Federal Technological University of Paraná, Brazil; *Edson Hideki Koroishi*, UTFPR, Brazil; *Fabian Andres Lara Molina*, UTFPR, Brazil; *Elenice Stiegelmeier*, UTFPR, Brazil.
- 9h30-9h50: TS-12-4 - **Simulations and details of a physical prototype addressing the influence of kinematic redundancy on a parallel robot**; *João Santos*, USP, Brazil; *Maíra da Silva*, USP, Brazil.
- 9h50-10h10: TS-12-5 **– Influence of Sample Rate and Discretization Methods in the Identification of Systems with Hysteresis**; *Wilson Junior,* UFSJ, Brazil; *Lucas Giovani Nardo*, UFSJ, Brazil; *Vinícius da Silva Borges*, UFSJ, Brazil; *Alisson Daniel de Macedo Vitor*, UFSJ, Brazil; *Samir A. M. Martins*, UFSJ, Brazil.

TS-13 – Synchronization and Complex Networks - III

Room: S1
Chair: Kelly Cristiane Iarosz, USP, São Paulo, Brazil

- 8h30-8h50: TS-13-1 - **Building phase synchronization equivalence between coupled bursting neurons and phase oscillators;** *Fabiano Ferrari***,** UFVJM, Brazil; *Ricardo Viana*, UFPR, Brazil.
- 8h50-9h10: TS-13-2 - **Collective dynamics in two populations of noisy oscillators with asymmetric interactions**; *Bernard Sonnenschein*, Humboldt University, Germany; *Thomas Peron*, USP, Brazil; *Francisco Rodrigues,* USP, Brazil; *Juergen Kurths*, Humboldt University, Germany; *Lutz Schimansky Geier*, Humboldt University, Germany.
- 9h10-9h30: TS-13-4 **– Structural Properties of Multiplex Networks**; *José Mendes,* Universidade de Aveiro, Portugal
- 9h30-09h50: TS-13-5. **– Ranking scientists**; *José Fernando Mendes*, Universidade de Aveiro, Portugal; *Sergey Dorogovtsev*, Universidade de Aveiro, Portugal.

10h30-10h45 – Coffee-Break

10h45-12:15 – Plenary Talks

Room: FM

- 10h45-11h30: P-13 – ***Mike Field***, Imperial College London, London, United Kingdom and Rice University, Houston, USA;
  A Modularization of dynamics theorem for asynchronous networks.

- 11h30-12h15: P-14 – ***Albert C. J. Luo***, Southern Illinois University, USA; Complete route of period-1 motions to chaos in a time-delayed Duffing oscillator.

12h15-13h30 – Lunch

13h30-15h30 – Parallel Sessions: Minisymposia and Contributive Sessions

TS-14 – Modeling, Numerical Simulation and Optimization – II

Room: FM
Chair: *José Mendes*, Universidade de Aveiro, Portugal

- 13h30-13h50: TS-14-1 - **A Short-Term Load Forecasting Model Based In Support Vector Machines;** *Ricardo Salgado*, UNIFAL, Brazil; *Takaaki Ohishi*, UNICAMP, Brazil.
- 13h50-14h10: TS-14-2 - **Comparative Study Of Short-Term Load Forecasting Models**; *Ricardo Salgado*, UNIFAL, Brazil; *Takaaki Ohishi*, UNICAMP, Brazil.
- 14h10-14h30: TS-14-3 – **A Monthly Streamflow Forecasting Model Using Bayesian Inference Theory**; *Ricardo Salgado*, UNIFAL, Brazil; *Bethânia Brito*, UNIFAL, Brazil; *Luiz Alberto Beijo*, UNIFAL, Brazil.
- 14h30-14h50: TS-14-4 – **Signal Propagation in Axons**; *Rosangela Follmann*, Illinois State University, USA; *Epaminondas Rosa*, Illinois State University, USA; *Wolfgang Stein*, Illinois State University, USA.
- 14h50-15h10: TS-14-5 – **Extending Numerical Solutions Of Potential Fields Method Based On Boundary Value Problems For 3d Environments**; *Marcelo O. Silva*, USP, Brazil; *Lucas Tomazela*, USP, Brazil; *Roseli F. Romero*, USP, Brazil.

TS-15 – Nonlinear Dynamical Systems and Application – III

Room: RH
Chair: *Liang Zhao*, USP, Brazil;

- 13h30-13h50: TS-15-1 - **Particle Trajectories Driven By Drift-Waves in Sheared Flows;** *Kaue Cabrera Rosalem*, ITA, Brazil; *Marisa Roberto*, ITA, Brazil; *Iberê Luiz Caldas*, USP, Brazil.
- 13h50-14h10: TS-15-2 - **Features of edge-centric collective dynamics in machine learning tasks**; *Liang Zhao*, USP, Brazil; *Filipe Verri*, USP, Brazil; *Paulo Urio*, USP, Brazil.
- 14h10-14h30: TS-15-3 – **Stationarity breaking in biological coupled physical systems in mice sleep revealed by recurrence analysis**; *Thiago Prado,* UFPR, Brazil; *Sergio Lopes*, UFPR, Brazil.
- 14h30-14h50: TS-15-4 – **Control of extreme events in the bubbling onset of wave turbulence**; *Paulo Galuzio*, UFPR, Brazil; *Ricardo Viana*, UFPR, Brazil; *Sergio Lopes*, UFPR, Brazil.
- 14h50-15h10: - **Community detection using coupled Kuramoto oscillators with conditional repulsion;** *João Eliakin Mota de Oliveira*, INPE, Brazil; *Marcos Daniel N. Maia*, INPE, Brazil; *Elbert E. N. Macau*, INPE, Brazil; Marcos G. Quiles, UNIFESP, Brazil.
- 15h10-15h30: TS-15-6 – **Watershed delineation – inverse problem and stochastic approach**; *Leonardo B. L. Santos*, CEMADEN, Brazil; *Tiago N. S. Miranda*, FATEC, Brazil; *Lucas V. Oliveira*, UNESP, Brazil; *Maria C. B. Jurema*, UNESP, Brazil; *Solon V. Carvalho*, INPE, Brazil.

TS-16 – Infinite Dimension Systems, Plasma and Turbulence – II

Room: S1
Chair: *Margarete Domingues*, INPE, São José dos Campos, Brazil

- 13h30-13h50: TS-16-1 - **On the verification of an adaptive three-dimensional magnetohydrodynamic model;** *Anna Karina Gomes*, INPE, Brazil; *Margarete Domingues*, INPE, Brazil; *Odim Mendes*, INPE, Brazil.
- 13h50-14h10: TS-16-2 - **The Characteristic Based Split scheme applied to solve the Navier-Stokes equations.**; *Gustavo Baggio*, UNESP, Brazil; *João Campos Silva*, UNESP, Brazil; *João Batista Aparecido*, UNESP, Brazil.
- 14h10-14h30: TS-16-3 – **Characterization of inhomogeneous turbulence from fluctuations of density and electromagnetic fields in space plasmas**; *Reinaldo Rosa,* INPE, Brazil.
- 14h30-14h50: TS-16-4 – **A new second order local time scheme for numerical simulations of evolutionary partial differential equations with ocalized physical phenomena**; *Müller Lopes*, INPE, Brazil; *Margarete Domingues*, INPE, Brazil; *Odim Mendes*, INPE, Brazil.
- 14h50-15h10: TS-16-5 –**Quality Denoising Heart Signal Experimentally Acquired,** *Guênia Ladeira*, Universidade Federal de Uberlândia, Brazil;
- 15h10-15h30: TS-16-6 – **Lagrangian Dynamics of Separation Bubble in Its Evolution from Generating to Breaking**; *Jiazhong Zhang*, Xi'an Jiaotong University, P. R. China.

15h30-15h45 – Coffee-Break

15h45-17h15 – Plenary Talks

Room: FM

- 15h45-16h30: P-15 – **Thomas Kapitaniak**, Technical University of Lodz, Poland
  Synchronization of pendula: From Huygens to chimeras
- 16h30-17h15: P-16 – ***Gonzalo M. Ramirez-Ávila**, Universidad Mayor de San Andrés, La Paz, Bolivia;*
  Arithmetic progression of spiking and bursting in Rulkov's Model

17h15-17h30 – Poster Award and Closing Ceremony

Poster Sessions

Poster Section I:

Chair: *Thiago Prado*, INPE, São José dos Campos, Brazil

Analysis and Control of Nonlinear Dynamical Systems with Practical Applications

- P-1-01: **Synchronization detection and characterization through mixed state embedding and recurrence quantification analysis**; *Leonardo Portes dos Santos*, UFMG, Brazil; *Luis Aguirre*, UFMG, Brazil.
- P-1-02: **Integrable classical restricted two-center MICZ-Kepler problem on surfaces of revolution**; *Yeva Gevorgyan*, UNESP, Brazil.
- P-1-03: **Discrete Complex Wavelet Approach Applied to Phase Synchronization on Solar Parameters**; *Maria Teodora Ferreira*, Faculdade Bilac e Univap, Brazil.
- P-1-04: **Simulation of Chua's Circuit by Means of Interval Analysis;** *Melanie Silva*, UFSJ, Brazil; *Erivelton Geraldo Nepomuceno*, UFSJ, Brazil; *Gleison Amaral*, UFSJ, Brazil; *Valceres Silva*, UFSJ, Brazil.
- P-1-05: **Nonlinear Particle Filter Applied to Orbit Determination of Artificial Satellites**; *Paula Pardal*, USP, Brazil; *Helio Kuga*, ITA/DCTA, Brazil; *Rodolpho Vilhena de Moraes*, UNIFESP, Brazil.
- P-01-06: **Analysis of the gravitational potential and the equilibrium points of the asteroid 2063 Bacchus**; *Tamires de Moura*, UNESP, Brazil; *Othon Winter*, UNESP, Brazil;
- P-01-07: **Order-Chaos-Order Transition in a Spring Pendulum**; *Francisco Marcus*, USP, Brazil; *Meirielen de Sousa*, USP, Brazil; *Iberê Luiz Caldas*, USP, Brazil;
- P01-08: **Suspension system in a spray boom using a fractional PID controller**; *Leonardo Magalhães*, USP, Brazil; *Sergio David*, USP, Brazil; *Rafael Sousa*, USP, Brazil; *Rubens Tabile*, FZEA-USP, Brazil.
- P01-09: **Synchronization detection and characterization through mixed state embedding and recurrence quantification analysis;** *Leonardo Portes dos Santos*, UFMG, Brazil; *Luis Aguirre*, UFMG, Brazil;
- P01-10: **On Nonlinear Oscillations Modelling in Structural Enginering and Solar Corona**; *Marcelo de Juli*, Universidade Presbiteriana Mackenzie, Brazil.
- P01-11: **Extension of the Invariance Principle for Switched Delay Systems;** *Michele Valentino*, Paraná Federal Technology University, Brazil.
- P01-12: **Parametric Dynamics of an Euler-Bernoulli Beam**; *Lílian Ribeiro*, UFSJ, Brazil; *Adelcio Oliveira*, UFSJ, Brazil.
- P01-13: **Analysing fractal basin boundaries in the Copenhagen problem;** *Sheila Assis*, Instituto Federal de Educação, Ciência e Tecnologia Catarinense IFC, Brazil; *Maísa de Oliveira Terra*, ITA, Brazil;
- P01-14: **Implementing the swarm algorithm in multi robots**; *Amir Hossein Omidvar,* UFABC, Brazil; *Luiz Martins Filho*, UFABC, Brazil; *Annibal Hetem Jr.*, UFABC, Brazil; *Atena Amanati Shahri*, UFABC, Brazil.

- P01-15: **Development of Contact Interaction-based Navigation of Mobile Robots**; *Atena Amanati Shahri*, UFABC, Brazil; *Luiz Martins Filho*, UFABC, Brazil; *Leandro Baroni*, UFABC, Brazil; *Amir Hossein Omidvar*, UFABC, Brazil;
- P01-16: **Kinetic instabilities in the electrochemical reform**; *José Cruz*, USP, Brazil; *Mayara Prado*, USP, Brazil; *Hamilton Varela*, USP, Brazil;
- P01-17: **Periodic Control Applied To The Attitude Control Of The Serpens II Mission**; *Felipe Coelho*, UFSM, Brazil; *André Luís da Silva*, UFABC, Brazil.
- P01-18: **Using micro and nanoresonators as pseudo-random numbers generators**; *Wellington Dantas*, UFF, Brazil; *André Gusso*, UFF, Brazil.
- P01-19: **Energy distribution in a spring pendulum**; *Meirielen de Sousa*, USP, Brazil; *Francisco Marcus*, USP, Brazil; *Iberê Luiz Caldas*, USP, Brazil.
- P01-20: **Interaction of scroll waves in an excitable medium**; *Nirmali Das*, IIT-Guwahati, India.
- P01-21: **Thermal Lattice Boltzmann Method for Dilute Fluids of Bosons and Fermions**; *Rodrigo Coelho*, UFRJ, Brazil; *Mauro Doria*, UFRJ, Brazil; *Anderson Ilha*, INMETRO, Brazil.
- P01-22: **A Lattice Boltzmann Method for Electrons in Metals**; *Rodrigo Coelho*, UFRJ, Brazil; *Anderson Ilha*, INMETRO, Brazil; *Mauro Doria*, UFRJ, Brazil.
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Bifurcation Analysis and Applications

- P01-23: **Simulation of Recursive Functions by Means of Interval Analysis and Pseudo-Orbits**; *Heitor Rodrigues Junior*, UFSJ, Brazil; *Márcia Peixoto*, UFSJ, Brazil; *Erivelton Geraldo Nepomuceno*, UFSJ, Brazil.
- P01-24: **Experimental results of the Chuas circuit**; *F.F.G Sousa*, IFSULDEMINAS, Brazil; *R.M. Rubinger,* UNIFEI, Brazil.
- P01-25: **Analysis of shear instability inside a flow driven by a cylindrical cavity**; *Waleed Mouhali*, ECE Paris, School of Engineering, France; *Thierry Lehner*, LUTH, France.
- P01-26: **Shearless bifurcation on symplectic map with a local null rotation number**; *Bruno Figueiredo Bartoloni*, USP, Brazil; *Iberê Luiz Caldas*, USP, Brazil.
- P01-27: **Complex dynamics in an electrochemical N-NDR oscillator**; *Alana Zülke*, USP, Brazil; *Hamilton Varela*, USP, Brazil; *Jason Gallas*, UFPB, Brazil.
- P01-28: **Mascons to find equilibrium points around small bodies of irregular shape**; *Gabriel Borderes Motta*, UNESP, Brazil; *Othon Winter*, UNESP, Brazil.
- P01-29: **Determination of asteroid shapes from lightcurves**; *Victor Lattari*, UNESP, Brazil.
- P01-30: **Chaos and hyperchaos in a reduced model of hydromagnetic convection**; *Francis F. Franco*, ITA, Brazil; *Erico L. Rempel*, ITA, Brazil

Celestial Mechanics and Dynamical Astronomy

- P01-31: **Magnetohydrodynamic equilibria with gravitational forces in symmetric systems**; *Fabiane Carvalho*, UFPR, Brazil; *Ricardo Viana*, UFPR, Brazil.
- P01-32: **The radial distribution of the dusty rings of Uranus**; *Rafael Sfair*, UNESP, Brazil; *Bruno Sicardy*, LESIA, France.
- P01-33: **Planetary formation in a coplanar triple stellar system**; *Luana Mendes*, UNESP, Brazil; *Rita Domingos*, UNESP, Brazil; *Othon Winter*, UNESP, Brazil; *André Izidoro*, UNESP, Brazil; *André Amarante*, UNESP e USP, Brazil.
- P01-34: **Alternative Paths to Reach Asteroids**; *Saymon Santana*, INPE, Brazil; *Cristiano de Melo*, UFMG, Brazil; *Elbert E. N. Macau*, INPE, Brazil; *Othon Winter*, UNESP, Brazil.
- P01-35: **Study of the dynamic of micrometric particles in the arcs of Neptune's Adams ring**; *Gustavo Madeira,* UNESP, Brazil*; Silvia M. G. Winter*, UNESP, Brazil.
- P01-36: **Hydrodynamics formation of the Gamma Cephei b;** *Bárbara Camargo*, UNESP, Brazil; *Ricardo Moraes*, UNESP, Brazil; *Othon Winter*, UNESP, Brazil; *Dietmar Foryta*, UFPR, Brazil.
- P01-37: **Testing anomalous diffusion models for simulation of cosmological density fluctuation spectra**; *Reinaldo Rosa*, INPE, Brazil; *Solon Carvalho*, INPE, Brazil; *Fernando Oliveira*, UnB, Brazil; *Mariana Pelissari Monteiro Aguiar Baroni*, IFSP, Brazil; *Diego Stalder Díaz*, INPE, Brazil.
- P01-38: **Testing the REBOUND in the Nice Model;** *Rafael Sousa*, UNESP, Brazil; *Ernesto Vieira Neto*, UNESP, Brazil.
- P01-39: **Study of Sailboat for binaries systems;** *Tiago F.L.L. Pinheiro*, UNESP, Brazil; *Rafael Sfair*, UNESP, Brazil.

Poster Section II:

Chair: *Rosana Araújo*, INPE, São José dos Campos, Brazil

Chaos and Global Nonlinear Dynamics

- P02-01: **Revisiting Hammel et al. (1987): Does the shadowing property hold for modern computers?**; *Bruno Silva*, UFSJ, Brazil; *Felipe Milani*, UFSJ, Brazil; *Erivelton Geraldo Nepomuceno*, UFSJ, Brazil; *Samir A. M. Martins*, UFSJ, Brazil; *Gleison Amaral*, UFSJ, Brazil.
- P02-02: **Dynamical Characterization Of Nonlinear Systems Through Complex Networks**; *Juliana Lacerda*, INPE, Brazil; *Vander Freitas*, INPE, Brazil; *Elbert E. N. Macau*, INPE, Brazil.
- P02-03: **An Alternative Method for the Dimension Calculation of Fractal Basin Boundaries**; *Vitor de Oliveira*, UFABC, Brazil; *Rafael Vilela*, UFABC, Brazil.

- P02-04: **Analysis of Coupled Drill-String Vibrations Using a Nonsmooth System**; *Luciano Moraes*, Centro Federal de Educação Tecnológica, Brazil; *Marcelo Savi*, UFRJ, Brazil.
- P02-05: **A web framework for advanced and intensive nonlinear time series analysis**; *Bruno Leonor*, INPE, Brazil; *Walter Abrahão dos Santos*, INPE, Brazil; *Asiel Bomfin Jr*, INPE, Brazil; *Reinaldo Rosa*, INPE, Brazil.
- P02-06: **Associative wavelets and complex networks detection of periodic windows in the logistic map: preliminary studies**; *Luciano Magrini*, INPE, Brazil; *Elbert E. N. Macau*, INPE, Brazil; *Margarete Domingues*, INPE, Brazil.
- P02-07: **Gradient pattern analysis of coupled map lattices**; *Rubens Sautter*, INPE, Brazil; *Pedro Batista*, IFSP, Brazil; *Reinaldo Rosa*, INPE, Brazil.
- P02-08: **Fractal structures in a model for E x B drift motion of charged particles in magnetized plasmas**; *Amanda Mathias*, UFPR, Brazil; *Ricardo Viana*, UFPR, Brazil; *Iberê Luiz Caldas*, USP, Brazil; *Tiago Kroetz*, USP, Brazil.

Climate Dynamics

- P02-09: **Manufacturing Optimization Using Coupled Lot Sizing and Stock Cutting Problems**; *Glaucia Bressan*, Universidade Tecnológica Federal do Paraná, Brazil; *Giovanna Salvadeo*, UTFPR, Brazil; *Roberto Souza*, UTFPR, Brazil.
- P02-10: **Cross-Sample Entropy Analysis for Oceanic Niño Index Data**; *Stéfano Silva*, IFMT, Brazil; *Raine Oliveira*, IFMT, Brazil; *Amanda Souza*, IFMT, Brazil; *Karla Morales*, IFMT, Brazil; *Manoel Moreira*, IFMT, Brazil.
- P02-11: **Bred Vector applied to the atmospheric dynamics;** *Luis Romero,* INPE, Brazil*; Sandra A. Sandri,* INPE, Brazil*; Haroldo F. De Campos Velho,* INPE, Brazil*; Rosângela S. C. Cintra;* INPE, Brazil*; Saulo R. Freitas*, INPE, Brazil.

Complex Networks

- P02-12: **Study of Communities in a Real Brain Network**; *Ewandson Lameu*, UEPG, Brazil.
- P02-13: **Effect of plasticity on the neuronal firing**; *Paulo Ricardo Protachevicz*, UEPG, Brazil; *Fernando da Silva Borges*, UEPG, Brazil; *Kelly Iarosz*, USP, Brazil; *Antonio Batista*, UEPG, Brazil; *Iberê Luiz Caldas*, USP, Brazil; *Ricardo Luiz Viana*, UFPR, Brazil.
- P02-14: **Relation Between Autocorrelation Sequence and Average Shortest-Path Length in a Time Serie to Network Mapping**; *Marcio Eisencraft*, USP, Brazil; *Amanda Camargo*, UFABC, Brazil.
- P02-15: **Time series from text co-occurrence networks**; *Camilo Akimushkin*, Instituto de Física de São Carlos, Brazil; *Diego Amancio*, USP, Brazil; *Osvaldo de Oliveira Jr.*, USP, Brazil.
- P02-16: **Cluster formation dynamics of heterogeneous agents**; *Alcides Castro e Silva*; UFOP, Brazil; *Everaldo Arashiro*, FURG, Brazil; *Eduardo Barbosa*, UFOP, Brazil; *Carlos Saraiva Pinheiro*, UFPO, Brazil.
- P02-17: **Properties of agent based epidemic models using coherent states**; *Gilberto Nakamura*, USP, Brazil; *Alexandre Martinez*, USP, Brazil.

- P02-18: **Investigating The Origin And Behavior Of Spontaneous Activities Of The Brain With Optical Methods**; *Sergio Novi Junior*, UNICAMP, Brazil; *Rickson Coelho Mesquita*, UNICAMP, Brazil.
- P02-19: **The local dynamic effect on frequecy synchronization of neuronal networks**; *Fabiano Ferrari*, UFVJM, Brazil; *Ricardo Viana*, UFPR; Brazil.
- P02-20: **Carrying capacity and accumulation of hubs in networks**; *Helder L. Casa Grande*, *Masayuki O. Hase*, Grupo de Modelagem de Sistemas Complexos – EACH/USP, São Paulo, Brazil.

Control in Complex Systems

- P02-21: **Dynamic optimization model to control weed infestation by herbicide rotation**; *Elenice Stiegelmeier*, UTFPR, Brazil; *Marcos Furlan*, UFGD, Brazil; *Renan Correa*, UTFPR, Brazil; *Vilma Oliveira*, USP, Brazil; *Geraldo Silva*, UNESP, Brazil.

Control of Chaos

- P02-22: **Plasma Response In Cylindrical Tokamaks With Toroidal Effects**; *André Carlos Fraile Júnior*, IEA, Brazil; *Marisa Roberto*, ITA, Brazil; *Iberê Luiz Calda*s, USP, Brazil.

Epidemiology and Mathematical Models

- P02-23: **Analysis of spatiotemporal patterns of reported cases of AIDS and tuberculosis in the city of São Paulo by administrative districts, using bayesian disease mapping**; *Elisangela Lizzi*, UTFPR, Brazil; *Edson Martinez*, USP, Brazil; *Antonio Ruffino Neto*, USP, Brazil; *Jonathan Golub*, John Hopkins University, USA.
- P02-24: **Correlated time series using mixed models in a Bayesian perspective**; *Roberto Souza*, UTFPR, Brazil; *Jorge Achcar*, USP, Brazil; *Glaucia Bressan*, UTFPR, Brazil.
- P02-25: **Solutions for Fractional Diffusion Equations with Reaction Terms**; *Ervin Lenzi*, UEPG, Brazil; *Marcelo Kaminski Lenzi*, UFPR, Brazil; *Raphael Menechini Neto*, UEPG, Brazil.
- P02-26: **Fractional Diffusion Equation with Radial Symmetry and Reactive Boundary Conditions**; *Marcelo Kaminski Lenzi*, UFPR, Brazil; *Ervin Lenzi*, UEPG, Brazil; *Andressa Novatski*, UEPG, Brazil; *Raphael Menechini Neto*, UEPG, Brazil; *Luciano Rodrigues da Silva*, UFRN, Brazil.
- P02-27: **Regime shift in a model for vector transmitted disease epidemics**; *Romuel Machado*, UFOP, Brazil; *Everaldo Arashiro*, FURG, Brazil.

Fluidodynamics, Plasma and Turbulence

- P02-28: **Using two-dimensional continuous wavelet transform to detect differences among primary forest, water bodies, clouds and cloud shadows on remote sensing images of an Amazon rain forest region: preliminary results**; *Margarete Domingues*, INPE, Brazil; *Cledenilson Mendonça de Souza*, UFAM/CSEZ, Brazil; *Marcos Adami*, CRAINPE, Brazil; *Leonardo Deane de Abreu Sá*, CRAINPE, Brazil.
- P02-29: **Irregular dynamics of the center of mass of droplets**; *Alexandre de Almeida*, USP, Brazil; *Nicolas Giovambattista*, University of New York, USA; *Sergey Buldyrev*, Yeshiva University, USA; *Adriano Alencar*, USP, Brazil.
- P02-30: **The Non-Axisymmetric Magnetic Separatrix In Fusion Plasmas**; *D. Ciro*, USP, Brazil; *Iberê Luiz Caldas*, USP, Brazil.

Modeling, Numerical Simulation and Optimization

- P02-31: **Modelling the Air-Water Interface**; *Frank Longford*, University of Southampton, UK; *Jeremy Frey*, University of Southampton, UK; *Jonathan Essex*, University of Southampton, UK; *Chris-Kriton Skylaris*, University of Southampton, UK.
- P02-32: **Modeling smart structures to reload smartphones using linear quadratic regulator (LQR) controller and the finite element method (FEM)**; *Stefânia Knebel*, UFMT, Brazil; *Marcelo Volz*, UFMT, Brazil; *Renato Santos de Souza*, UFMT, Brazil; *Aguinaldo Soares*, UFMT, Brazil.
- P02-33: **Axiomatic Local Metric Derivatives With Mittag-Leffler Eigenfunctions for Low-Level Fractionality**; *José Weberszpil*, UFRRJ, Brazil; *José Helayel*, Centro Brasileiro de Pesquisas Fisicas, Brazil.
- P02-34: **Identification of a nonlinear beam through a stochastic model based on a Duffing oscillator**; *Luis Villani*, UNESP, Brazil; *Samuel Silva*, UNESP, Brazil; *Americo Cunha Jr*, UERJ, Brazil.
- P02-35: **Dynamic of neuronal membrane using a numerical model**; *Marina González*, IFSP, Brazil; *Mariana Pelissari Monteiro Aguiar Baroni*, IFSP, Brazil; *Marco Aurélio Santos*, IFSP, Brazil.
- P02-36: **Analysis of RR intervals time serie using second-order difference plot**; *Laurita Santos*, UNIVAP, Brazil; *Joaquim José Barroso*, ITA, Brazil; *Moacir de Godoy*, FAMERP, Brazil; *Elbert E. N. Macau*, INPE, Brazil.
- P02-37: **Assessment the change on rhythm cardiac produces by the metabolic syndrome in rats: using nonlinear methods**; *Alondra Albarado Ibañez*, Benemérita Universidad Autonoma de Puebla, Mexico; *Marcia Hiriart*, UNAM, Mexico; *Julian Torres Jacome*, Benemérita Universidad Autonoma de Puebla, Mexico.
- P02-38: **Estimation of Dynamical Phase Models for Chaotic Oscillators;** *Leandro Abreu*, IFMG, Brazil; *Luis Aguirre*, UFMG, Brazil.

Abstracts

Periodicity and chaos: Self-organization in lasers, circuits, and complex flows

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Nonlinear flows described by sets of ordinary differential equations have been used extensively to model generic oscillators describing lasers of several types, electronic circuits, chemical and biochemical models, and more. The reason is that such flows provide a fair representation of complex facts observed experimentally. Apart from standard control parameters, such equations allow one to incorporate delayed feedback through additional parameters that render the models infinite dimensional and hard to deal with. For a review, see Ref. [1]. Traditionally, equations of motion are solved for specific situations of interest but over quite restricted parameter intervals. Here, we survey a number of very recent numerical studies analyzing very large portions of the control parameter space for a few models of current interest. Of particular interest are parameter regions where one finds accumulations of oscillations having complex pattern structures, forming large mosaics in control space, but, surprisingly, are completely free from chaotic oscillations. Such mosaics of *stable* oscillations define regions where one might easily implement "control", i.e. to change oscillatory patterns by performing just a single change of parameters, with no need for the continuous application of external feedback (as it is usual in popular control methods in the literature).

References

[1] Jason A.C. Gallas, *Systematics of spiking in some CO_2 laser models*, invited chapter in *Advances in Atomic, Molecular, and Optical Physics* **65**, in print (2016).

Keywords:
Analysis and Control of Nonlinear Dynamical Systems with Practical Applications
Nonlinear Dynamics and Complex Systems
Nonlinear Dynamics in Lasers Control in Complex Systems

Dynamics of Phase Oscillators with Generalized Coupling

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(Underline the name of the author whom will present the paper)

Abstract: The emergence of collective behavior is a fascinating feature of interacting oscillatory units in nature and technology. We study systems of phase oscillators which provide an approximation for weakly coupled oscillators. In contrast to the classical Kuramoto equations, where the interaction is determined by the sine of the phase differences, we are interested in symmetrically coupled networks where the interaction can have more than one nontrivial Fourier component. On the one hand, we are interested in the effect generalized coupling has on the dynamics and bifurcations occurring in the system. On the other hand, we investigate how generalized coupling can be exploited in applications, for example to design and potentially control desired localized dynamics. This is joint with Peter Ashwin (Exeter) and Oleksandr Burylko (Kyiv).

keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Synchronization in Nonlinear Systems, Nonlinear Dynamics and Complex Systems, Dynamics of Oscillatory Systems.

SYSTEMS WITH POWER-LAW MEMORY AND FRACTIONAL DYNAMICS

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Abstract: Systems with power-law memory are common in natural and social sciences and engineering. The most appealing is appearance of power-law memory in biological applications. A consistent consideration of discrete systems with power-law memory can be done through the use of fractional Eulerian numbers. It can be shown that systems with power-law memory can be described by fractional difference/differential equations.
Due to the integro-differential nature of fractional derivatives, investigation of general properties of fractional differential equation is very difficult. To investigate general properties of fractional dynamics we consider fractional maps, which can be derived from fractional differential equations with periodic kicks or, in the case of essentially discrete systems, from fractional difference equations.
Using the fractional standard map (harmonic nonlinearity) and the fractional logistic map (quadratic nonlinearity) as examples we show that nonlinear systems with power-law memory demonstrate a new type of attractors - cascade of bifurcation type attractors, power-law convergence/divergence of trajectories, bifurcations with changes in the memory parameter, intersection of trajectories, and overlapping of attractors.

keywords: Nonlinear Fractional Dynamics, Cascades of Bifurcations, Fractional Attractors, Systems with Memory.

Basin Entropy: A new tool to explore uncertainty in dynamical systems

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In nonlinear dynamics, basins of attraction link a given set of initial conditions to its corresponding final states. This notion appears in a broad range of applications where several outcomes are possible, which is a common situation in neuroscience, economy, astronomy, ecology and many other disciplines. Depending on the nature of the basins, prediction can be difficult even in systems that evolve under deterministic rules. From this respect, a proper classification of this unpredictability is clearly required. To address this issue, we introduce the basin entropy, a measure to quantify this uncertainty. Its application is illustrated with several paradigmatic examples that allow us to identify the ingredients that hinder the prediction of the final state. The basin entropy provides an efficient method to probe the behavior of a system when different parameters are varied. Additionally, we provide a sufficient condition for the existence of fractal basin boundaries: when the basin entropy of the boundaries is larger than *log 2*, the basin is fractal. This is joint work with Alvar Daza, Alexandre Wagemakers, Bertrand Georgeot and David Guéry-Odelin.

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[2] Alvar Daza, Alexandre Wagemakers and Miguel A. F. Sanjuán. Wada property in systems with delay. Commun Nonlinear Sci Numer Simulat, 2016

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Acoustic radiation force, dynamics of particles and bubbles in acoustic field, and biomedical applications

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Abstract for the NSC meeting, Sao Jose dos Campos, Brasil, 2016

The acoustic radiation force (radiation pressure, radiation stress) is, in general, defined as a period-average force exerted on the medium by a sound wave. Various aspects of this phenomenon in fluids have been discussed by numerous authors, beginning with Lord Rayleigh. At present, different variants of the acoustic radiation force (ARF) are widely used in microfluidics, chemistry, biology and medicine. Among the promising areas of its application is concentration and stirring of particles and bubbles in ultrasonic resonators. This problem is associated with a complex individual and collective dynamics of particles. Here, after a brief historical outline, we consider complex problems of individual and collective motion of particles and bubbles in standing waves of plane and cylindrical geometry. In particular, concentration and separation of "heavy" and "light" particles and near-resonant bubbles are discussed. The possibility of keeping particles stirred by periodic change of acoustic wavelength, is confirmed as well. Distribution and separation of microbubbles of different sizes in a standing wave is also studied. Examples of available experimental data illustrating these processes are also given.

Hopf bifurcation and chaos in a third-order phase-locked loop

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Abstract: Phase-locked loops (PLLs) are devices able to recover time signals in several engineering applications. The literature regarding their dynamical behavior is vast, specifically considering that the process of synchronization between the input signal, coming from a remote source, and the PLL local oscillation is robust. For high-frequency applications it is usual to increase the PLL order by increasing the order of the internal filter, for guarantying good transient responses; however local parameter variations imply structural instability, thus provoking a Hopf bifurcation and a route to chaos for the phase error. Here, one usual architecture for a third-order PLL is studied and a range of permitted parameters is derived, providing a rule of thumb for designers. Out of this range, a Hopf bifurcation appears and, by increasing parameters, the periodic solution originated by the Hopf bifurcation degenerates into a chaotic attractor, therefore, preventing synchronization.

keywords: bifurcation, chaos, nonlinear dynamics, synchronization, numerical simulation.

Constructive Nonlinear Dynamics: Integrating Applied Bifurcation Theory with Optimization

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Abstract:
Model based optimization is common practice in the engineering disciplines. Nonlinear programming, for example, can be applied to find economically optimal steady states, if a system model (such as a set of nonlinear ODE) is available. Optimization, however, naturally drives dynamical systems to their limits. Often modes of operation result that are optimal economically, but unstable, or that are optimal but have other undesirable dynamical properties.
We present an approach that integrates stability boundaries and related boundaries into nonlinear programming. Essentially, the critical boundaries of interest are manifolds of bifurcation points, and the distance of any candidate optimal point to these manifolds can locally be described with normal vectors. The approach has successfully been applied to the steady state and periodic mode optimization of nonlinear ODE, discrete time systems and delay differential equations with uncertain parameters. It is illustrated with examples from energy systems, chemical and biochemical engineering.

Keywords:
- Analysis and Control of Nonlinear Dynamical Systems with Practical Applications
- Bifurcation Analysis and Applications
- Modeling, Numerical Simulation and Optimization

Powerlaw Decays and Thermalization in Chaotic Quantum Systems

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Abstract: We study the evolution of isolated many-body quantum systems after an abrupt perturbation. The short-time decay of the survival probability is faster than exponential for sufficiently strong perturbations. This initial evolution does not depend on whether the system is integrable or chaotic. At long-times the dynamics necessarily slows down and shows a powerlaw behavior. From the value of the powerlaw exponent, we infer how well filled the energy distribution of the initial state is. Its ergodic filling indicates that the system will reach thermal equilibrium, that is, the infinite-time averages of few-body observables agree with their thermodynamic averages.

- **keywords**: Chaos and Global Nonlinear Dynamics, Complex Networks, Control of Chaos, Quantum Nonequilibrium Dynamics, Thermalization of Isolated Many-Body Quantum Systems

AVOIDING BLACKOUTS WITH THE THEORY OF STABILITY REGIONS

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Abstract: The concept of *stability region* (also called region of attraction or basin of attraction) encounters many practical applications in sciences and engineering, but it was in the problem of transient stability of power systems that engineers encountered motivation to develop a comprehensive *theory of stability regions*. The objectives of this plenary are two: (i) to offer an overview of the existing characterization of stability regions and stability boundaries and (ii) to illustrate how the theory of stability region is employed to assess transient stability of large-scale power systems on real time.

keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Complex Networks, Nonlinear Dynamics and Complex Systems, Stability of Power Systems, Stability Region.

Fractional Calculus: Fundamentals and Applications

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Abstract: Fractional Calculus (FC) started in 1695 when L'Hôpital wrote a letter to Leibniz asking for the meaning of $D^n y$ for $n = 1/2$. Starting with the ideas of Leibniz many important mathematicians developed the theoretical concepts. By the beginning of the twentieth century Olivier Heaviside applied FC in the electrical engineering, but, the visionary and important contributions were forgotten. Only during the eighties FC emerged associated with phenomena such as fractal and chaos and, consequently, in nonlinear dynamical. This lecture introduces the FC fundamental mathematical concepts, and reviews the main computational approaches for implementing fractional operators. In the last years Fractional Calculus (FC) become 'new' tool for the analysis of dynamical systems. Based on the FC mathematical concepts, this lecture presents several applications in the areas of systems modeling and control.

keywords: Fractional calculus, modeling, dynamical systems.

Complexity in Unconstrained and Constrained Optimization *

J. M. Martínez[†]

February 2016

Abstract

Practical algorithms for unconstrained and constrained nonlinear optimization have been developed since, approximately, 1960. Most theoretical analyses reported the ability of the algorithms to find ε-optimal solutions, that is, points that satisfy an approximate optimality condition with precison ε, where $\varepsilon > 0$ is arbitrary. Accordingly, most convergence results take the form "Every limit point is stationary" or, at least, "There exists a stationary limit point". In the present century an ambitious research program is being developed that aims to "quantify" the computer work that is necessary to achieve precision ε. For example, the computer work required by the steepest descent and other gradient-related methods is (at most) $O(1/\varepsilon^2)$. This is also the case of well-known implementations of Newton's method based on line searches or trust regions. This fact is frustrating because it seems to indicate that the complexity analysis does not reflect practical efficiency. Fortunately, recent research shows that the "well-known" implementations of Newton's method are not the ones that provide better complexity than $O(1/\varepsilon^2)$ but implementations based on new "regularization" techiques provide better complexity bounds. As a by-product it has been shown that the complexity analysis provides a better justification of practical performance than the classical asymptotic arguments.

Keywords: Complexity, Nonlinear optimization, Cubic modeling, Newton-type methods.

*This work was supported by PRONEX-CNPq/FAPERJ (E-26/111.449/2010-APQ1), CEPID–Industrial Mathematics/FAPESP (Grant 2011/51305-02), FAPESP (projects 2013/05475-7 and 2013/07375-0), and CNPq (project 400926/2013-0).

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Expanding Dynamics on Heterogeneous Networks: Mean Field Reduction and Synchronisation

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Abstract:Experiments in the last two decades showed that complex networks exhibit heterogeneous and scale free structure meaning that most of the nodes are poorly connected while a small number of nodes called hubs is massively connected to the rest of the network. Examples are found in social interactions, the internet, power grid networks, the brain and many others. In this type of structure synchronisation between the highly connected nodes is often observed. A dynamical theory for the synchronisation phenomenon on heterogeneous networks remains a major challenge. I will discuss an ergodic approach to describe bifurcations for the hubs behaviour leading to synchronisation under expansion of the local dynamics sitting on each node and sufficient regularity of the coupling.

keywords: Complex Networks, Synchronization in Nonlinear Systems, Chaos and Global Nonlinear Dynamics, Nonlinear Dynamics and Complex Systems.

A MODULARIZATION OF DYNAMICS THEOREM FOR ASYNCHRONOUS NETWORKS

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Abstract: We have developed a theory of *asynchronous networks* that gives a theoretical and conceptual framework for the study of network dynamics where nodes can evolve independently of one another, be constrained, stop, and later restart, and where the interactions between different components of the network may depend on time, state, and stochastic effects. Potential applications range from engineering to neuroscience. Typically dynamics is piecewise smooth and there are relationships with Filippov systems. In this talk we describe a factorization of dynamics theorem that addresses the question of modularization of dynamics addressed by Alon in the introduction to his book on systems biology

"Ideally, we would like to understand the dynamics of the entire network based on the dynamics of the individual building blocks"

keywords: Complex Networks, Nonlinear Dynamics and Complex Systems, Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Event driven dynamics, Asynchronous Networks.

Complete routes of period-1 motions to chaos in a time-delayed Duffing oscillator

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Abstract: Analytically searching complete routes of periodic motion to chaos is a key to understand global pictures of motions in nonlinear dynamical systems. Simple numerical simulations cannot obtain the global views of motions in the nonlinear dynamical systems. In this paper, a semi-analytical method is used to determine bifurcation trees of periodic motions in a periodically forced, time-delayed, hardening Duffing oscillator as an example. Such a semi-analytical method is based on the differential equation discretization of the time-delayed, nonlinear dynamical system. Bifurcation trees for the stable and unstable solutions of periodic motions to chaos in such a time-delayed, Duffing oscillator are achieved analytically. From the finite discrete Fourier series, harmonic developed are frequency-amplitude curves for stable and unstable solutions of period-1 to period-4 motions. Numerical results of periodic motions in the time-delayed Duffing oscillator are also carried out for the complexity and asymmetry of period-1 motions to chaos in nonlinear dynamical systems.

Keywords: Bifurcation Analysis and Applications, Time-delayed Duffing oscillator; Period-1 motions to chaos; Bifurcation tree; Implicit mapping

ARINTHMETIC PROGRESSIONS OF SPIKING AND BURSTING IN RULKOV'S NEURON MODEL

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Abstract: We report the discovery of nested arithmetic progressions among pulsing and bursting phases of Rulkov's *discrete-time* neuron model. Rulkov's map displays complex nested progressions of the *period* of the oscillations. These intricate nesting are robust and can be observed abundantly in several control parameter planes that we describe in detail..

keywords: Bifurcation Analysis and Applications, Modeling, Numerical Simulation and Optimization, Nonlinear Systems and Neural Dynamics.

SYNCHRONIZATION OF PENDULA: FROM HUYGENS TO CHIMERAS

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Abstract: The main purpose of this model is to present the format to be used for abstract submission. Use up to 600 letters in elaborating your abstract.

keywords: Synchronization in Nonlinear Systems, Nonlinear Dynamics and Complex Systems, Complex Networks, Chimera states.

We recall the famous Huygens' experiment which gave the first evidence of the synchronization phenomenon. We consider the synchronization of two clocks which are accurate (show the same time) but have pendula with different masses. It has been shown that such clocks hanging on the same beam can show the almost complete (in-phase) and almost antiphase synchronizations. By almost complete and almost antiphase synchronization we defined the periodic motion of the pendula in which the phase shift between the displacements of the pendula is respectively close (but not equal) to 0 or π. We give evidence that almost antiphase synchronization was the phenomenon observed by Huygens in XVII century. Additionally we discuss the synchronization of a number of different pendulum clocks hanging from a horizontal beam which can roll on the parallel surface. It has been shown that after a transient, different types of synchronization between pendula can be observed; (i) the complete synchronization in which all pendula behave identically, (ii) pendula create three or five clusters of synchronized pendula. We derive the equations for the estimation of the phase differences between phase synchronized clusters. The evidence, why other configurations with a different number of clusters are not observed, is given.

The phenomenon of chimera states in the systems of coupled, identical oscillators has attracted a great deal of recent theoretical and experimental interest. In such a state, different groups of oscillators can exhibit coexisting synchronous and incoherent behaviors despite homogeneous coupling. Here, considering the coupled pendula, we find another pattern, the so-called imperfect chimera state, which is characterized by a certain number of oscillators which escape from the synchronized chimera's cluster or behave differently than most of uncorrelated pendula. The escaped elements oscillate with different average frequencies (Poincare rotation number). We show that imperfect chimera can be realized in simple experiments with mechanical oscillators, namely Huygens clock. Finally, we uncover the mechanism of the creation of the chimera states by perturbations to the fully synchronized state. The mathematical model of our experiment shows that the observed chimera states are controlled by elementary dynamical equations derived from Newton's laws that are ubiquitous in many physical and engineering systems.

MS1-TRANSIENT CHAOS IN COMPLEX SYSTEMS

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Description: Transient chaos refers to chaotic phenomena that appear in a finite lifetime. In contrast to permanent chaos associated with the asymptotic state, transient chaos are associated with a nonequilibrium state that has different behavior from the asymptotic behavior of a system. Examples of complex phenomena and dynamical structures related to transient chaos are: chaotic saddles, chaotic leaking systems, crises, on-off intermittency, edge of chaos, chaotic advection, fractal basin boundaries, transport barriers, and turbulence. This mini-symposium aims to discuss the concepts and applications of transient chaos in astrophysics, biology, fluids, and plasmas.

keywords: Transient chaos, chaotic saddle, crisis, spatiotemporal chaos, turbulence

Number of talks: 5

TALKS

ROUTE TO HYPERCHAOS AND INTERMITTENCY IN RAYLEIGH-BERNARD CONVECTION

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Abstract. Transition to hyperchaotic regimes in Rayleigh-Benard convection in a square periodicity cell is studied by three-dimensional numerical simulations. By fixing the Prandtl number and varying the Rayleigh number as a control parameter, a bifurcation diagram is constructed where a route involving quasiperiodic regimes with two and three incommensurate frequencies, multistability, chaotic intermittent attractors and a sequence of boundary and interior crises is shown. The three largest Lyapunov exponents exhibit a linear scaling with the Rayleigh number and are positive in the final hyperchaotic attractor. Thus, a route to weak turbulence is found.

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E. V. Chimanski, R. Chertovskih, E. L. Rempel. Intermittency route to hyperchaos in 3D Rayleigh-Benard convection. Advances in Space Research, in press (2016)

keywords: Bifurcation, hyperchaos, chaotic saddle, intermittency, Rayleigh-Benard convection

EDGE OF CHAOS AND GENESIS OF TURBULENCE

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Abstract: The edge of chaos is analyzed in a spatially extended system, modeled by the regularized long-wave equation, prior to the transition to permanent spatiotemporal chaos. In the presence of coexisting attractors, a chaotic saddle is born at the basin boundary due to a smooth-fractal metamorphosis. As a control parameter is varied, the chaotic transient evolves to well-developed transient turbulence via a cascade of fractal-fractal metamorphoses. The edge state responsible for the edge of chaos and the genesis of turbulence is an unstable traveling wave in the laboratory frame, corresponding to a saddle point lying at the basin boundary in the Fourier space.

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keywords: Edge of chaos, chaotic saddle, turbulence, regularized long-wave equation, multistability

SUPERTRANSIENT AND AMPLITUDE-PHASE SYNCHRONIZATION IN ASTROPHYSICAL SHEAR FLOWS

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Abstract: We study the development of coherent structures in local simulations of the magnetorotational instability in accretion discs in regimes of on–off intermittency. In Chian et al. (2010), we have shown that the laminar and bursty states due to the on–off spatiotemporal intermittency in a onedimensional model of non-linear waves correspond, respectively, to non-attracting coherent structures with higher and lower degrees of amplitude-phase synchronization. In this paper, we extend these results to a three-dimensional model of magnetized Keplerian shear flows. Keeping the kinetic Reynolds number and the magnetic Prandtl number fixed, we investigate two different intermittent regimes by varying the plasma beta parameter. The first regime is characterized by turbulent patterns interrupted by the recurrent emergence of a large-scale coherent structure known as two-channel flow, where the state of the system can be described by a single Fourier mode. The second regime is dominated by the turbulence with sporadic emergence of coherent structures with shapes that are reminiscent of a perturbed channel flow. By computing the Fourier power and phase spectral entropies in three dimensions, we show that the large-scale coherent structures are characterized by a high degree of amplitude-phase synchronization.

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R. A. Miranda, E. L. Rempel, A. C.-L. Chian. On–off intermittency and amplitude-phase synchronization in Keplerian shear flows. Mon. Not. Royal Astron. Soc. **448,** 804–813 (2015)

keywords: On-off intermittency, amplitude-phase synchronization, accretion discs, magnetohydrodynamics, turbulence

TRANSPORT BARRIERS IN BIDIMENSIONAL AND MULTIDIMENSIONAL SYSTEMS

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Abstract: We present a set of generic results on transport barriers for nonlinear Hamiltonian dynamics. We show the necessary conditions for a Hamiltonian system to present a nontwist scenario and from that we introduce isochronous resonances. We define a special kind of transport barrier called robust torus. Shearless curves are also presented and we show the most robust shearless barrier associated with the rotation numbers. Finally, we investigate features of a transport barrier in a four dimensional map.

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keywords: Transport barriers, Hamiltonian systems, isochronous resonances, robust torus, rotation numbers

BOUNDARY CRISIS AND CHAOTIC TRANSIENT IN A MODEL OF TUMOR GROWTH

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Abstract: We consider a dynamical model of cancer growth including three interacting cell populations of tumor cells, healthy host cells and immune effector cells. For certain parameter choice, the dynamical system displays chaotic motion and by decreasing the response of the immune system to the tumor cells, a boundary crisis leading to transient chaotic dynamics is

observed.This means that the system behaves chaotically for a finite amount of time until the unavoidable extinction of the healthy and immune cell populations occurs. Our main goal here is to apply a control method to avoid extinction. For that purpose, we apply the partial control method, which aims to control transient chaotic dynamics in the presence of external disturbances. As a result,we have succeeded to avoid the uncontrolled growth of tumor cells and the extinction of healthy tissue.The possibility of using this method compared to the frequently used therapies is discussed.

Álvaro G.López, Juan Sabuco, Jesús M. Seoane, Jorge Duarte, Cristina Januário, and Miguel A.F. Sanjuán. Avoiding healthy cells extinction in a cancer model. Journal of Theoretical Biology **349**, 74–81 (2014)

Álvaro G. López, Jesús M. Seoane, Miguel A. F. Sanjuán. A validated mathematical model of tumor growth including tumor–host interaction, cell-mediated immune response and chemotherapy. Bulletin of Mathematical Biology**76**, 2884–2906 (2014)

keywords: Crisis, chaotic transient, dynamical modeling, cancer growth, control

Chaos, scaling laws and dynamical systems

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Description : The aim of this minisymposium is to drawn an overview for dynamical systems that can be described by scaling laws arguments and also interpret some of the phenomena that the non-linearity can bring to their dynamics. Very often these systems may present chaotic behavior in both dissipative and non-dissipative dynamics. In the non-dissipative case, a mixed phase space, with invariant tori, KAM islands and chaotic seas if often observed. Depending of the combination of control parameters and initial conditions, some variables of these systems can be described by scaling laws and classes of universality can be obtained. In the dissipative dynamics, chaotic attractors can lead the dynamics to different scenarios, where transients and assymptotic behavior of some variables can also be setup by scaling arguments. Also, self-similarity structures in the parameter space can be obtained and characterized by means of uncertainty exponents, and anomalous transport can be obrserved in different billiard systems.

keywords: Chaos, phase transitions, scaling laws, billiards.

Number of talks: 6

TALKS

1) A dynamical phase transition for a family of Hamiltonian mappings: a phenomenological investigation to obtain the critical exponents

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Abstract: A dynamical phase transition from integrability to non-integrability for a family of 2-D Hamiltonian mappings whose angle, θ, diverges in the limit of vanishingly action, I, is characterised. The mappings are described by two parameters: (i) ϵ, controlling the transition from integrable ($\epsilon=0$) to non-integrable ($\epsilon\ne 0$) and; (ii) γ denoting the power of the action in the equation which defines the angle. We prove the average action is scaling invariant with respect to either ϵ and n and obtain a scaling law for the three critical exponents.

keywords: phase transitions, scaling laws, critical exponents.

2) Chaotic dynamics in an elliptical billiard with soft walls

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Abstract: Physical systems such as optical traps and microwave cavities are commonly modeled by two-dimensional billiards. A possible generalization of the concept of a billiard is that of a soft-wall system. Billiards with soft walls provide more realistic models for trapped particles, since physically realizable potentials are typically smooth. In order to investigate the influence of the soft-wall nature on the billiard dynamics, we study numerically a smooth two-dimensional potential well that has the elliptical hard-wall billiard as a limiting case. We intend to determine the effect of softness on the dynamics of a billiard that both is integrable at the hard-wall limit and also presents an heteroclinic structure in phase space. Considering two parameters -- the eccentricity of the elliptical equipotential curves and the wall \emph{hardness}, which defines the steepness of the well wall -- we show that (i) whereas the hard-wall limit is integrable and thus completely regular, the soft wall elliptical billiard exhibits chaos, (ii) the chaotic fraction of the phase space depends non-monotonically on the hardness of the wall, and (iii) the effect of the hardness on the dynamics depends strongly on the eccentricity of the soft-wall billiard. We find that, similarly to the generalization of the LRA Conjecture, here too the phase space fragility seems to give rise to unexpectedly rich and unstable behavior.

keywords: Elliptical billiard, smooth potential boundary, phase transitions, chaos.

3) Chaotic Explosions

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Abstract: We investigate chaotic dynamical systems for which the intensity of trajectories might grow unlimited in time. We show that i) the intensity grows exponentially in time and is distributed spatially according to a fractal measure with an information dimension smaller than that of the phase space, ii) such exploding cases can be described by an operator formalism similar to the one applied to chaotic systems with absorption (decaying intensities), but iii) the invariant quantities characterizing explosion and absorption are typically not directly related to each other, e.g., the decay rate and fractal dimensions of absorbing maps typically differ from the ones computed in the corresponding inverse (exploding) maps. We illustrate our general results through numerical simulation in the cardioid billiard mimicking a lasing optical cavity, and through analytical calculations in the baker map.

keywords: chaotic dynamics, systems with absorption, cardioid billiard.

4) Sensitive Dependence on Parameters of Continuous-time Nonlinear Dynamical Systems

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Abstract: The final asymptotic behavior of nonlinear dynamical systems can be severely affected by small perturbations of the system control parameters. This parameter sensitivity has been experimentally observed in different areas of knowledge. The cause of such sensitivity is the existence of bifurcation sets able to change the system dynamics regardless of any scale in the control parameter sets. The most dramatic consequence of such sensitivity is to limit the ability of one surely set the parameters of a system to oscillate in a desired asymptotic behavior. Here, we quantify the parameter sensitivity between periodicity and chaos for continuous-time dynamical, specifically, by obtaining the uncertainty exponent for their parameter sets

keywords: chaos, bifurcations, parameter space, uncertainty exponent.

5) Scaling laws and critical exponents in discrete mappings

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Abstract: Convergence to fixed points in one-dimensional logistic-like mappings is investigated. The mappings are parametrized by a control parameter γ as a dynamical variable. As the control parameter is varied bifurcations in the fixed points appear. We verified at the bifurcation point in the transcritical and pitchfork bifurcations, that the decay for the stationary point is characterized via a homogeneous function with three critical exponents depending on the nonlinearity of the mapping. Near the bifurcation the decay to the fixed point is exponential with a relaxation time given by a power law whose slope is independent of the nonlinearity. The formalism is general and can be extended to other dissipative mappings.

keywords: scaling laws, critical exponents, bifurcations, logistic-like mappings.

6) Stickiness influence in a driven stadium-like billiard: An ensemble separation mechanism

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Abstract: A competition between decay and growth of energy in a time-dependent stadium billiard is discussed giving emphasis in the decay of energy mechanism. A critical resonance velocity is identified for causing of separation between ensembles of high and low energy and a statistical investigation is made using ensembles of initial conditions both above and below the resonance velocity. For high initial velocity, Fermi acceleration is inherent in the system. However for low initial velocity, the resonance allies with stickiness hold the particles in a regular or quasi-regular regime near the fixed points, preventing them from exhibiting Fermi acceleration. Also, a transport analysis along the velocity axis is discussed to quantify the competition of growth and decay of energy and making use distributions of histograms of frequency, and we set that the causes of the decay of energy are due to the capture of the orbits by the resonant fixed points. We also used finite time Lyapunov exponents to characterize the stickiness influence

keywords: stickiness, anomalous transport, Fermi acceleration, resonance.

MS3-Dynamics and synchronization in complex networks

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Description : Complex behavior seen in nature arises from the coupling of many small and simple subsystems. To describe the topology of interactions, the machinery of complex network theory is often employed. The main purpose of this minisymposium is to bring together different people working on different dynamics, with special attention to synchronization phenomena, on complex networks, such that perspectives and experiences can be shared among the participants.

keywords: Complex Networks, Synchronization, Dynamics on complex networks.

Number of talks: 12

TALKS

Synchrony patterns on gradient networks

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(Underline the name of the author whom will present the paper)

Abstract: We present recent results for detecting synchrony on networks of coupled gradient systems. There are constraints for a vector field to be defined on a network and these are called admissbile vector fields. Here we present the general form of admissible functions, that is, functions whose gradient is an admissible vector field. Synchrony patterns of the network are singularities of the admissible functions. We discuss existence and nature of such singularities and how they are related to the architecture of the graphs defining the network. This is part of a joint work with Mark Roberts (M Manoel, M. Roberts, Gradient systems on coupled cell networks Nonlinearity 28 3487-3509, 2015).

keywords: network, undirected graph, gradient vector field

Robust heteroclinic networks in coupled identical cell networks: Realization and patterns of synchronization

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Abstract: It is often relatively easy to identify and classify large classes of robust heteroclinic networks and cycles in certain classes of equivariant dynamics and systems governed by generalized Lotka-Volterra equations. On the other hand, there is a lack of methods for identifying and classifying heteroclinic networks in coupled identical cell systems, where the emphasis is on patterns of synchronization. We describe results that enable the transformation of known results about systems governed by (say) generalized Lotka-Volterra equations to the setting of coupled identical cell systems. As a consequence we obtain a natural realization of a large class of robust heteroclinic networks in coupled identical cell systems. We describe some of this work, what it means it terms of desynchronization and resynchronization along heteroclinic connections, and briefly indicate potential applications to neural microcircuits, sequence generation and spatio-temporal encoding as developed by Afraimovich, Rabinovich, Ashwin, and others.

keywords: Complex Networks, Nonlinear Dynamics and Complex Systems, Synchronization in Nonlinear Systems, Identical cell networks, Heteroclinic Networks.

Effects of synaptic plasticity on the synchronisation in neural network

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Abstract: The human brain is one of the most complex part of the body. The brain has about 100 billion neurons where it is assumed that each neuron has 10,000 synapses. The synapses can be electrical or chemical. The chemical synapses can be minimised or potentiated, and the mechanism responsible for these adjustments is known as synaptic plasticity. In other words, synaptic plasticity is the ability of synapses to weaken or strengthen over time, and it is an important property of the mammalian brain. Moreover, the synaptic plasticity is related with processes of learning and memory. This adjustment of the intensities of the chemical synapses can be correlated with phenomena of synchronisation of the neuronal firing. We have been studying the e□ects of spike timing-dependent plasticity on synchronisation in neural network. We have observed that the synchronisation depend on the connectivity. When a strong external perturbation is applied in the network, the synchronisation is suppressed. Nevertheless, with synaptic plasticity, depending on the connectivity, the synchronisation in the perturbed network can be improved due to a constructive e□ect on the synaptic weights.

keywords: Synchronization, Synaptic plasticity, Brain.

Squared sine logistic map

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Abstract: A periodic time perturbation is introduced in the logistic map as an attempt to investigate new scenarios of bifurcations and new mechanisms toward the chaos. With a squared sine perturbation we observe that a point attractor reaches the chaotic attractor without following a cascade of bifurcations. One fixed point of the system presents a new scenario of bifurcations through an infinite sequence of alternating

changes of stability. At the bifurcations, the time perturbation does not modify the scaling features observed in the convergence towards the stationary state.

keywords: Bifurcation theory, chaos, scalling

Synchronization and Applications

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Abstract: The object of this lecture is to study some applications of Synchronization to nonlinear models, most of them chaotic, in the areas of Engineering, Phisics, Biology, etc. Special emphasis will be given to Communication Systems where chaotic models will be used to codify and to decode signals. Some simulations and some videos will be presented. Also some mathematical methods that are used to prove synchronization will be discussed.

keywords: Applications of Synchronization, Nonlinear models, Communication Systems

Connectivity-Driven Coherence in Complex Networks

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We study the emergence of coherence in complex networks of mutually coupled nonidentical elements. We uncover the precise dependence of the dynamical coherence on the network connectivity, the isolated dynamics of the elements, and the coupling function. These findings predict that in random graphs the enhancement of coherence is proportional to the mean degree. In locally connected networks, coherence is no longer controlled by the mean degree but rather by how the mean degree scales with the network size. In these networks, even when the coherence is absent, adding a fraction s of random connections leads to an enhancement of coherence proportional to s. Our results provide a way to control the emergent properties by the manipulation of the dynamics of the elements and the network connectivity.

keywords: synchronization, complex networks, bifurcations, random graphs

Using neuroimaging techniques to reveal the brain complex networks at rest

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Abstract: Measuring cerebral activity with advanced neuroimaging techniques has been a useful approach to

explore the complex functional organization of the brain. In this talk we will review the main neuroimaging techniques currently employed to assess cerebral activity during the resting state. In particular, we will present our most recent results on using functional Magnetic Resonance Imaging (fMRI) and near-infrared spectroscopy (NIRS) to assess the spontaneous activity of the human brain during the resting state.

keywords: Complex Networksm Nonlinear Dynamics and Complex Systems, Time Series Analysis.

General model of epidemic spreading in networks

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Abstract: Information spreading is pervasive in nature, society and engineering. We propose a general epidemic spreading model based on discrete time Markov chains. Our model covers not only the traditional models of rumor and disease spreading, but also include some properties of recent models, such as apathy, forgetting, lost and recovering of interest in information diffusion. The model is evaluated analytically to obtain the spreading threshold for the contact and reactive processes. The comparison with Monte Carlo simulation shows that our model is very accurate. This study may contribute to the analysis of disease and rumor spreading under the same theoretical framework.

keywords: Epidemic models, Rumor models, Markov chains

Hidden symmetries in coupled cell network vector fields

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Abstract: Dynamical systems with a network structure share striking similarities with equivariant systems, such as invariant spaces, degenerate spectra and unusual bifurcations as a generic phenomenon. We show that this is no coincidence, as under a natural condition every network system can be embedded in an equivariant system. This 'hidden symmetry' is often no group action though, but rather a monoid symmetry. We show in particular how this view leads to a center manifold theory for networks.

keywords: Simmetries, vector fields, complex networks

Dynamics of phase oscillator populations with heterogeneous phase lags

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Abstract: The emergence of patterns of spatially localized coherence and incoherence—commonly know as chimera states—has received considerable attention in recent years. We study the effect of heterogeneous

phase lags in populations of coupled phase oscillators on the emergence of chimera states and other collective dynamics

Keywords: Chimeras, pattern formation, heterogeneity

Chimera states from explosive synchronization

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Abstract: Explosive synchronization and chimera states are two very active areas of research in the last years. We show here that, at least for suficiente weak coupling, we can build chimera states from the region of bistability induced by the positive degree frequency correlation. Our results are based on mathematical considerations, as well as numerical results.

Keywords: Chimeras, explosive synchronization, synchronization

Stochastic Quasispecies Model: Form Self-Replicating Polynucleotides to RNA viruses.

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Abstract: The quasi-species model introduced by Manfred Eigen and Peter Schuster provides a description of the process of evolution of self-replicating macromolecules in the framework of chemistry. The model of quasi-species were originally proposed to describe the evolutionary process of self-replicating acromolecules such as RNA, but more recently, the concept of quasi-species has been applied to populations of a viruses within a host. This approach is considered relevant to RNA viruses because they have high mutation rates and extremely large diverse viral populations. This diversity allows a viral population quickly adapt to dynamic environments and develop resistance to vaccines and antivirals. In fact, a large number of clinically significant viruses, including HIV, hepatitis C, influenza viruses have RNA genomes. Many predictions of the theory of viral quasi-species contradicts traditional views of behavior and microbial evolution and have profound implications for the understanding of viral diseases. In this talk we will present a stochastic version of the quasispecies model based on multivariate branching process and discuss some of its predictions and extensions.

keywords: Self-replicating molecules, quasi-species, evolution

MS-4-Chaos-based communications and signal processing

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Description: In the last decades many possible applications of nonlinear dynamics in communication systems and signal processing have been reported. Conversely, techniques usually employed by the signal processing and communication systems community, as correlation, power spectral density analysis and linear filters, have been used to characterize chaotic dynamical systems. This minisymposium will present works that aim to use tools from both fields to generate new and interesting results.

keywords: Nonlinear Dynamics, chaos, spectral analysis, signal processing, communication systems.

Number of talks (4 to 8): 6

TALKS

Chaotic Map Sequence as Fingerprint for Physical Authentication System

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Abstract: Message authentication, which ensures that a received message comes from its acclaimed sender, is of fundamental importance for secure communication systems. Traditionally, authentication methods are deployed in higher layers of the network which provide a computational secrecy to the system, meaning that algorithms running in a polynomial computer will not be able to break the secrecy in feasible time. However, exploring the stochastic nature of the wireless channel, usually seem as an undesired characteristic, is an efficient way to provide an additional security layer to the system. In this context, we consider in this work a physical layer authentication system employing fingerprints embedded in the message providing a robust authentication method. The fingerprint embedding system can be deployed on top of an existing system where users employing the authentication protocol can communicate without interfering with users unaware to the authentication scheme. This work diverges from previous work in the area when it comes to the fingerprint generation method. While the previous works use methods based on cryptographic hash functions and on the channel state information our system employs unidimensional chaotic maps to generate these fingerprints. Due to the fact that sequences generated by these maps are broadband, aperiodic and presents noise-like behavior we show that they are strong candidates for the fingerprint generation process. Every message has its own fingerprint that is generated by the iteration of the chaotic map. Additionally, in this work we show that due to the entropy generated by the stretching and folding of the phase space that occur in unidimensional chaotic maps the sequences generated by the maps can provide a robust physical layer authentication scheme, with information theoretic security against replay, substitution and impersonation attacks with controlled failure rates.

keywords: message authentication, chaotic maps, information-theoretic security, fingerprint.

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Spectral Properties of the Orbits of the Hénon map

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Abstract: Recently, many works have explored the spectral characterization of one-dimensional discrete-time chaotic signals, considering them as sample functions of a stochastic process defined by the map. In this paper, we numerically access the autocorrelation sequence and power spectral density of orbits generated by a two-dimensional chaotic map, namely the Hénon map. We study how they vary with the map parameters and the largest Lyapunov exponent. These results may be relevant for chaos-based communication systems that uses maps to codify messages.

Keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Time Series Analysis, Discrete Dynamical Systems.

Acknowledgements: The authors thank FAPESP (2014/04864-2) and CNPq (479901/2013-9 449699/2014-5 and 311575/2013-7) for the financial support.

White Gaussian Chaos

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Abstract: A discrete-time white Gaussian noise (WGN) is a random process that has impulsive autocorrelation function. Besides, the random variables obtained sampling the process at N time instants are jointly Gaussian. WGN is used to model noise in many different areas in Engineering and Science because of many relevant mathematical properties that simplify analysis. In some contexts, e.g. wireless communications, it can be considered a worst case scenario. It is also an accurate model of some physical phenomena, due to the Central Limit Theorem.

Discrete-time chaotic signals are deterministic by definition. Nonetheless, they can be studied using the formalities usually employed in the analysis of random signals. In summary, an ergodic discrete-time one-dimensional map can be seen as a random process whose sample functions are determined by different initial conditions.

In this paper, we propose a simple way to generate chaotic signals that behaves like WGN when it comes to their autocorrelation function and invariant density. Departing from the logistic map that has closed formula for its iterations, and using conjugacy and transformations of random variables we obtain our white Gaussian chaos.

Numerical simulations are shown to illustrate the technique.

Keywords: Gaussian noise, Chaotic behaviour, Random processes, Discrete-time systems.

Acknowledgements: The author thanks FAPESP (2014/04864-2) and CNPq (479901/2013-9 449699/2014-5 and 311575/2013-7) for the financial support.

Chaotic Properties of the Hénon Map with a linear filter

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Abstract: An interesting way of limiting the bandwidth of the transmitted signal in a chaos-based communication scheme is to use linear discrete-time filters in the feedback loop. It was recently proved that such filters do not disturb chaotic synchronization. However, there is no guarantee that the generated signals remain chaotic. In this paper, we consider the Hénon map plus a linear time-invariant finite impulsive response filter. We numerically access its largest Lyapunov exponent as a function of the filter coefficients, obtaining regions where chaotic, periodic or unbounded orbits are present.

Keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Nonlinear Dynamics and Complex Systems, Discrete Dynamical Systems, Time Series Analysis.

Acknowledgements: The authors thank FAPESP (2014/04864-2) and CNPq (479901/2013-9 449699/2014-5 and 311575/2013-7) for the financial support.

IIR Equalization Based on Complexity Measures in the Context of Chaotic Information Sources

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Abstract: The problem of equalization can be described as that of using a filter to provide precise estimates of an information signal sent through a communication channel. It is closely related to the problem of blind source separation (BSS), which calls for the recovery of a set of information sources from mixtures of them using a minimum of *a priori* information. Pajunen, in 1998, proposed a BSS method based on complexity minimization in the sense of algorithmic information theory [1]. His method was based on the assumption that, at least in certain cases, a mixture of signals is more complex than the signals themselves. Complexity was estimated, in practice, by quantizing the signal of interest and using Lempel-Ziv coding. In the work of Soriano et al. [2], the idea is, in a certain sense, revisited, but in the context of signals generated by dynamical systems and complexity measures derived from recurrence plots. In another work by Soriano et al. [3], there is a significant novelty – the complexity measure for performing BSS is associated with an estimate of the Kolmogorov complexity of a recurrence plot. In a more recent paper [4], a preliminary study was carried out to verify how well this philosophy would suit the problem of channel equalization, which, in the case of a linear channel, is a sort of BSS task involving samples of the same signal in the role of sources. In the case of chaotic signals, this will lead to dependent sources, and it is possible, in principle, to relate the degree of dependence to the dynamic properties of the underlying information-generating system. The discussion presented in [1] revealed that, at least for an infinite impulse response (IIR) channel, the complexity measures explored in [2] and [3] could lead to perfect channel inversion. In this work, we will introduce a novelty with respect to [4] – the use of

an IIR equalizer to invert a finite impulse response (FIR) channel. This case is an interesting test, as a small FIR channel tends to alter in a relatively subtle way the signal complexity, thereby posing a challenge *per se*. The experiments show that, in the case of minimum-phase channels of the form $H(z) = 1 + \alpha z^{-1}$, and using as transmitted signal the normalized (zero mean and unit variance) time series derived from the logistic map with $\mu = 4$, the minimum square error (MSE) between the source signal and the recovered signal is of the order of magnitude of 10^{-3}. The complexity was estimated by the ZIP-compression of the recurrence plots of the involved signals. Through this procedure, we verified that the recovery process depends significantly on the parameters of the recurrence plot - the results are susceptible to diverge with very small changes of them. This leads us to conclude that the use of complexity measures is feasible in unsupervised equalization under some specific circumstances, although a more careful study of the role of the time structure of the information source and a deep investigation of the parameters of the recurrence plot are necessary.

Keywords: chaotic signal processing, channel equalization, complexity measures

Acknowledgements: The authors thank CNPq (449699/2014-5, 449467/2014-7 and 302890/2012-2) for the financial support.

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A Switching Scheme Between Conventional and Chaos-based Communication Systems

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Abstract: Many communication systems based on the synchronization of chaotic systems have been proposed as an alternative spread spectrum modulation that improves the level of privacy in data transmission. However, due to the lack of robustness of complete chaotic synchronization, even minor channel impairments are enough to hinder communication. In this paper, we propose an encoding function for chaos-based communication systems that can assure the generation of chaotic signals. Moreover, the encoding function parameters can be adjusted so that the transmitted signal can range from a conventional communication signal to a chaotic one, presenting sensitive dependence on initial conditions. Based on this function, we present an adaptive equalization scheme that allows us to recover the transmitted sequence in different non-ideal scenarios. In spite of the advantages of the proposed system when using chaotic signals, the performance in terms of bit error rate is poor in comparison with a conventional communication system without chaos. Inspired by Wireless Fidelity (Wi-Fi) technology, which switches the modulation depending on the communication channel quality, we propose an algorithm to switch between the chaos-based communication system and the conventional one. The switching is triggered based on a threshold applied to the mean square decision error (MSE). In the proposed system, if MSE is greater than -35

dB, the conventional communication system is used. On the hand, when the channel conditions get better and MSE becomes lower than -35 dB, the system returns to the chaotic regime. Preliminary simulation results show that the switching and equalization algorithms can successfully recover the transmitted sequence in different scenarios.

Keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Chaos and Global Nonlinear Dynamics, Synchronization in Nonlinear Systems.

Acknowledgements: The authors thank FAPESP (2014/04864-2) and CNPq (479901/2013-9 449699/2014-5 and 311575/2013-7) for the financial support.

MS-5-Computational Neuroscience

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Description : Computational Neuroscience combines techniques from nonlinear and stochastic dynamics, information theory and other theoretical fields to offer both predictions to new phenomena and unifying, principle-unveiling explanations for known experimental results. This mini-symposium will address both individual and collective properties of neuronal dynamics.

keywords: Nonlinear Systems and Neural Dynamics, Nonlinear Dynamics and Complex Systems, Stochastic Models.

Number of talks: 4

TALKS

Collective Dynamics suppresses Fluctuations

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Abstract: In many neuronal networks the fluctuations in the network output is much lower than the fluctuations in the input signal. We will discuss how the network structure plays a fundamental role to reduce these fluctuations.

keywords: Nonlinear Systems and Neural Dynamics, Nonlinear Dynamics and Complex Systems, Stochastic Models.

Conditional Lyapunov Exponents for Izhikevich Neuronal Model

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Abstract: The Izhikevich (IZ) neuronal model has been adopted as a benchmark in theoretical neuroscience, and exhibits one of the best relations between biological plausibility and computational cost. The present work aims to analyze the synchronism of unidirectional coupled IZ neurons by means of the conditional Lyapunov exponent evaluation. In order to overcome the analytical difficulties imposed by its discontinuous structure, we apply a saltation matrix theory to the variational equations.

keywords: Discontinuous Dynamical Systems, Nonlinear Systems and Neural Dynamics, Synchronization in Nonlinear Systems, Conditional Lyapunov exponents, Izhikevich model.

Colored noise and memory effects on formal spiking neuron models

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Abstract: We propose a neuron model described by a generalized Langevin equation that takes into account memory effects and colored noise. We perform a comprehensive numerical analysis to study the dynamics and the point process statistics of the proposed model, highlighting interesting new features like: i) non-monotonic behavior of the coefficient of variation (CV) as a function of memory characteristic time-scale, ii) colored noise-induced shift in the CV, and iii) emergence and suppression of multimodality in the interspike interval (ISI) distribution due to memory-induced subthreshold oscillations.

keywords: Nonlinear Systems and Neural Dynamics, Stochastic Models, Nonlinear Dynamics and Complex Systems.

On the beneficial role of memory for signal detection by threshold systems

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Abstract: In this work we study stochastic resonance (SR) in the context of an extension of the second order resonate-and-fire model. The subthreshold dynamics of this generalized model is provided by a Langevin-like equation that takes into account memory effects (distributed delay) and colored noise. We analyze in detail how the presence of memory and colored noise modifies the conditions for the viability of SR. We show that, given an optimal amount of noise, it is also possible to determine an optimal value of the characteristic time parameter of the memory which improves the establishment of SR.

keywords: Nonlinear Systems and Neural Dynamics, Stochastic Models, Nonlinear Dynamics and Complex Systems.

MS-6-COMPLEX NETWORKS AS AN INTERDISCIPLINARY TOOL ON MEASUREMENT OF CRITICAL INFRASTRUCTURE'S VULNERABILITY AGAINST NATURAL DISASTERS

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Abstract: Natural disasters cause great human and material losses worldwide and its growing risk is a matter of global concern, especially with the prospects of increased frequency and intensity of extreme precipitation events. Structures such networks, with complex connections and interdependencies, permeate the research on Natural Disasters, from hydrography systems (threats) to critical infrastructure networks (impacts). Nonlinear Science and Complexity applications on natural disaster's researches are scientifically and socially relevant (http://oglobo.globo.com/sociedade/ciencia/a-matematica-na-prevencao-de-desastres-naturais-16981638).

keywords: Complex Networks, natural disasters, hydrography, critical infrastructure, nowcasting

1. CONCEPTUAL INTERFACES BETWEEN THE NATURAL DISASTER TERMINOLOGY AND COMPLEX SYSTEMS THEORY

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Abstract: Some interactions between different knowledge areas have been done with success. As examples, the evolutive computing, based on Darwin's evolution theory, and Artificial Neural Networks, based on Neuroscience. In this work we analyze the similarities and differences of terminology for Disaster Risk Management (United Nations Office for Disaster Risk Reduction – UNISDR, and Brazilian Civil Defense) and Complex Systems theory, exploring key-words like vulnerability, adaptation and resilience, with particular interest in quantifications based on Complex Network models.

keywords: Disaster risk management, complex systems theory, vulnerability, adaptation, resilience.

PGHYDRO – HYDROGRAPHIC OBJECTS IN SPATIAL DATABASE MANAGEMENT SYSTEM

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Abstract: The pgHydro represents the first innovation as an add-on on spatial database management system (PostGIS/PostgreSQL) in water resources decision-making using a series of hydrographic network objects related such as tables, queries, functions, constraints or views. These objects make up the hydrographic basin of the intelligence system and are part of pgHydro open source project, composed by pghydro schema and pghydro tools. This proposal uses the logic elements based on Pfafstetter's basin coding system.

Keywords – pgHydro, spatial database management system, Pfafstetter basin coding.

WEATHER RADAR FORECASTING FOR NATURAL DISASTERS EARLY WARNING AT THE SCALE OF SUSCEPTIBILITY AREAS

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Abstract: In 2014, the Brazilian government, through the National Centre for Monitoring and Early Warning of Natural Disasters (Cemaden), installed nine weather radars (doppler, S-band, dual polarization) to aid the monitoring of great number of risk areas for landslide, floods and flashfloods, particularly in urban regions. The purpose of this lecture is to present a automatic tool based on weather radar nowcasting at the scale of susceptibility area, based on a value of accumulated rainfall.

Keywords – Nowcasting, weather radar, susceptibility areas, early warning.

COMPLEX NETWORKS IN GEOGRAPHICAL INFORMATION SYSTEMS - CROSSING HYDROGRAPHY AND TRANSPORTATION NETWORKS

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Abstract: Geographic databases and geographic information systems allow manipulation, visualization and analysis of data with explicit spatial component. Complex networks can be geographically studied once known the location of nodes and when the rule of creating edges presents some spatial dependence, as occurs in hydrography and transport routes. The crossing of transport infrastructure (from urban streets to highways) and watercourses (rivers and synthetic drainage) define a fragile element to be studied by an algebra of complex networks.

keywords: Spatial networks, strahler, vulnerability, drainage, natural disasters.

SURVIVABILITY EVALUATION OF CRITICAL INFRASTRUCTURES

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Abstract: The infrastructures used in cities to supply power, water and gas are consistently becoming more automated. As these cyber-physical infrastructures play increasingly more important roles, their survivability assessment deserves special attention. In this talk, we introduce a taxonomy of recent work on topics related to the survivability of cyber-physical infrastructures. We focus on approaches that consider the system behavior given the occurrence of failures, and organize them according to their domain as well as to the tools used to analyze the problems.

MS-7-NONLINEAR DYNAMICS OF CONSERVATIVE AND DISSIPATIVE COMPLEX SYSTEMS

Organizer: Ricardo Luiz Viana[1]

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Description : The main purpose of this minisymposium is to present recent developments in the nonlinear dynamics of conservative and dissipative complex systems, emphasizing applications in various fields like plasma physics, complex networks, turbulence and diffusion.

keywords: nonlinear dynamics, conservative systems, dissipative systems, complex networks, plasma physics, turbulence, diffusion, resonances, drift motion

Number of talks: 6

TALKS

1. Analysis of Plasma Turbulence in Texas Helimak

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Abstract: We analyze alterations on the electrostatic turbulence in experiments with imposed bias to control the plasma radial electric field in Texas Helimak, a toroidal plasma device with a one-dimensional equilibrium, magnetic curvature and shear. We present the main characteristics of fluctuations observed in a roughly uniform gradient region. When the bias is positive, the turbulence shows enhanced and broadband spectra with non Gaussian PDFs having noticeable long tails (extreme events). On the other hand, negative bias reduces the turbulence level and decreases the spectrum widths. Moreover, for a negative bias, the transport is high where the waves propagate with phase velocities near the plasma flow velocity, an indication that the transport is strongly affected by a wave particle resonant interaction. On the other hand, for positive bias values, we find evidences of transport barrier.

keywords: plasma turbulence, electrostatic turbulence, plasma transport

2. Community detection in complex networks via dynamics

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Abstract: We use the dynamics of complex networks to identify communities. A well appropriated mathematical approach is used to study the behavior of the model's solutions. A quality function called clustering density is introduced to measure the effectiveness of the communities identification. Illustrations with real networks with community structure are presented.

keywords: complex networks, community detection, network dynamics

3. Synchronization of nonlinear phase oscillators with coupling mediated by a diffusing substance

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Abstract: We investigate the transition to phase and frequency synchronization in a one-dimensional chain of phase oscillator "cells" where the coupling is mediated by the local concentration of a chemical which can diffuse in the inter-oscillator medium and it is both secreted and absorbed by the oscillator "cells", influencing their dynamical behavior. This coupling has the advantage of having a tunable parameter which makes it possible to pass continuously from a global (all-to-all) to a local (nearest-neighbor) coupling form.

keywords: phase oscillators, synchronization, nonlocal coupling, Kuramoto system

4. Control of anomalous transport and stickiness in Hamiltonian systems

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Abstract: In this paper we study how hyperbolic and nonhyperbolic regions in the neighborhood of a resonant island perform an important role allowing or forbidding stickiness phenomenon around islands in conservative systems contributing to anomalous transport and super diffusion displayed by Hamiltonian systems. In particular the phase space topology of theses systems plays a crucial role in the anomalous transport and in sticky phenomena. The vicinity of the island is composed of nonhyperbolic areas that almost prevent the trajectory to visit the island edge. For some specific parameters tiny channels are embedded in the nonhyperbolic area that are associated to hyperbolic fixed points localized in the neighborhood of the islands. Such channels allow the trajectory to be injected in the inner portion of the vicinity. When the trajectory crosses the barrier imposed by the nonhyperbolic regions, it spends a long time abandoning the vicinity of the island, since the barrier also prevents the trajectory from escaping from the neighborhood of the island. In this scenario the nonhyperbolic structures are responsible for the stickiness phenomena and, more than that, the strength of the sticky effect. We show that those properties of the phase space allow us to manipulate the existence of extreme events (and the transport associated to it) responsible for the nonequilibrium fluctuation of the system. In fact we demonstrate that by monitoring very small portions of the phase space (namely, 10^{-5} of it) it is possible to generate a completely diffusive system eliminating long-time recurrences that result from the stickiness phenomenon.

keywords: anomalous transport, stickiness, nonhyperbolicity

5. Escape time and transport in E x B drift motion

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Abstract: We have been studying escape time and chaotic particle transport in magnetized plasmas with two electrostatic drift waves. Drift waves play a relevant role in transport of particles in magnetically confined plasmas. We consider a dissipation in the two-wave Hamiltonian particle transport induced by electrostatic waves propagating in the poloidal direction in a magnetized plasma with a constant toroidal magnetic field. The effect of dissipation on Hamiltonian systems has been an important topic of research. In this work, we verify that the basin of attraction properties depends on the dissipation and the space-averaged escape time decays exponentially when the dissipation is increased. In addition, we have also verified the existence of a transient chaotic transport.

keywords: drift motion, escape time, transport

6. Coexistent subharmonic resonant modes of a forced bilinear oscillator

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Abstract: The occurrence of subharmonic resonances in a forced bilinear oscillator and the organization of these resonances on the parameter space is numerically studied is this work. The system is a damped oscillator presenting a piecewise linear restoring force with a discontinuity at the equilibrium position. In spite of the anharmonic feature of the bilinear oscillator, its natural frequency does not depend on the amplitude of oscillation. Consequently, the oscillations exhibit subharmonic resonances, where the periods are multiples of the forcing period. Varying the control parameters of damping, forcing frequency and the ratio between elastic constants of linear parts, is possible to associate each set of parameters with a specific subharmonic resonant mode. By performing this procedure extensively and associating each subharmonic mode with a color, we obtain a description of the system dynamics displayed on a parameter space. The parameter space contains domains of subharmonic resonant modes and chaotic dynamics displayed on a hierarchical organization that obeys a period-adding rule. Some of the domains are mediated by a window of periodic motion between them, which separates and coexists with different subharmonic modes of periods that are related. Also, depending on the damping parameter, is possible to identify a period-doubling route to chaos suffered by each subharmonic domain coexistent with the periodic motion.

keywords: bilinear oscillators, subharmonic resonances, parameter space

MS-8-MINISYMPOSYUM TITLE: Lie group analysis and its applications

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Description : Several mathematical models that describe many phenomena in natural sciences, such as physics, biology, engineering, and economics can be modelled by nonlinear differential equations. However, it is difficult to obtain exact solutions of such nonlinear differential equations.

The Lie group analysis approach is considered to be a milestone in the search for solutions of nonlinear differential equations. In fact, although this approach is not always able to characterize the whole set of solutions, it allows one to get wide classes of exact solutions in a methodological way. Moreover the knowledge of symmetries admitted by an equation does not bring only to a reduction of independent variable but allows us to get conservation laws or to first integrals.

In the last few decades, a large amount of publications in theoretical and applied mathematics are devoted to the Lie group analysis methods and their applications.

The Lie group method specifies and extends the concept of symmetry, yields the effective methods of symmetry applications in complicated situations, gives correct statement of problems and in many cases indicates the possible way of their solutions.

The aim of this minisymposium is to focus the attention of scientists on symmetry methods to search for exact solutions of nonlinear models in physics, in engineering science, and in biology as well as to show recent developments of the theoretical tools of the Lie group methods applicable to the study of differential equations.

keywords: Nonlinear dynamics and applications, Mathematical modeling, symmetries, conservation laws.

TALKS

TITLE_1 Some Conservation laws of a Boussinesq equation with strong internal damping

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Abstract: In this work considering the effect of viscosity in real process we consider a generalized Boussinesq equation with strong internal damping from the point of view of Lie classical reductions. In order to find all conservations laws for evolution equation Anco and Bluman gave a general algorithmic method, called direct method or multiplier method. A special method to derive conservation laws, which does not require the existence of Lagrangians has been introduced by Ibragimov. This method, is based on the concept of adjoint equations for nonlinear equations and avoids the integrals of functions. We will derive some nontrivial conservation laws by using the multiplier method of Anco and Bluman as well as the theorem on conservation laws introduced by N.H. Ibragimov

keywords: Nonlinear, systems, modeling, symmetries, conservation laws

TITLE_2

NONLINEAR SELF-ADJOINTNESS AND CONSERVATION LAWS OF A GENERALIZED BENJAMIN-BONA-MAHONY-BURGERS EQUATION

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Abstract: In this paper we consider the equation

$$u_t + bu_x + a\,(u^m)_x + (u^n)_{xxt} + c\,(u^k)_{xx} = 0 \qquad (1)$$

where a, b and c are arbitrary constants. In [5] equation (1) was denominated Generalized Benjamin-Bona-Mahony-Burgers equation. Bruzón *et all* analyzed the classical and nonclassical symmetries of equation (1) with c=0 [3]. Furthermore, Bruzón and Gandarias proved that this equation is self-adjoint [6]. By using a general theorem on conservation laws [7], they constructed conservation laws for this equation associated with its Lie symmetries.

In [5] Bruzón and Gandarias obtained the complete Lie group classification for equation (1) and the corresponding reduced equations were derived from the optimal system of subalgebras. The authors determined solutions for equation (1) in terms of the Jacobi elliptic functions. They also derived travelling wave solutions for equation, among them kinks solutions. Moreover, they proved that the symmetries of the potential system does not yield potential symmetries of equation.

In this work we proved that equation (1) taking different values of the arbitrary constants is nonlinear self-adjoint and we construct new conservation laws by applying the direct construction method of Anco and Bluman [1,2]. We also derive new exact solutions.

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- **keywords**: Nonlinear Dynamics and Applications, Fluid dynamics, Mathematical Models.

TITLE_3

Solutions and conservation laws of a class of nonlinear dispersive wave equations

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In this talk we study a damped externally excited Korteweg-de Vries (KdV) equation with a forcing term. We construct the Lie point symmetries of the equation and use them to obtain some exact solutions which are periodic waves and solitary waves. These solutions are derived from the solutions of a simple nonlinear ordinary differential equation. Moreover, by employing a general theorem on conservation laws and the multiplier method, we derive conservation laws for some of these partial differential equations.

keywords: Nonlinear, systems, modeling, symmetries, conservation laws.

TITLE_4

An optimal system and group-invariant solutions of the Vasicek pricing equation of mathematical finance

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In this talk the one factor term structure model by Vasicek is analysed from the point of view of Lie symmetry analysis. Its one-parameter Lie point symmetries and the corresponding group of adjoint representations are obtained. An optimal system of one-dimensional subalgebras is derived and is then used to obtain symmetry reduction and group-invariant
solutions. Some of the group-invariant solutions presented here are new and have not appeared in the literature.

keywords: Nonlinear, systems, modeling, symmetries, conservation laws.

UNCERTAINTY ANALYSIS OF SMART COMPOSITE MATERIALS

Fabian Andres Lara-Molina1, **Edson Hideki Koroishi1**, Albert Willian Faria[2]

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Abstract: The recent years have seen the appearance of innovative materials, as the so-called composite materials, particularly in aerospace applications. The structures constructed by this innovated arrangement are characterized by lightness, mechanical resistance, and the possibility to be optimized for a specific working condition. Unlike the regular materials (steel, aluminum, etc), the composites are formed by various layers with different fiber orientations, which allows to be adequated for a particular application. Aircraft, aerospace and automotive industries are examples in which the composite materials have been increasingly used. Generally, piezoelectric layers (PZT sensor/actuator patch) are incorporated to the composite materials in order to offer potential benefits in a wide range of applications such as structural health monitoring, noise suppression, precision positioning and active vibration control. Thus, the set encompassing the composite material, piezoelectric layers and monitoring and control systems, is known as Smart Composite Structure. Moreover, the industrial applications require mechanical systems working with optimal performance subject to specific operational conditions, which demands: high reliability, robustness against environmental conditions and low operating requirements. Consequently, it is necessary to develop reliable numerical models that take into account uncertain parameters, and allow the prediction of the dynamic behavior of the system under realistic conditions. The present contribution is dedicated to the analysis of uncertainties affecting the dynamic behavior of a piezoelectric actuator bonded to a composite structure forming a so-called smart composite structure. Serendipity-type finite element based on first-order shear deformation theory with rectangular shape, eight nodes, five mechanical degrees of freedom (DOF) per node and eight electrical DOF per piezoelectric layer is established for the composite structural model. Additionally, a mixed theory that uses a single equivalent layer for the discretization of the mechanical displacement field and a layerwise representation of the electrical field is adopted. Temperature effects are neglected. With respect to the uncertain analysis, the stochastic method has been extensively used to analyze uncertain parameters, by means of the so-called Monte Carlo simulation. However, the fuzzy theory permits to model the uncertainty as an alternative to the stochastic methods. By means of fuzzy theory it is possible to describe incomplete and inaccurate information. The theory of fuzzy sets and the theory of possibilities are connected, so that it is possible to get along with the uncertainty and imprecision of the information sets by applying the fuzzy sets theory. Therefore, the inherent uncertainties are modeled with the aid of fuzzy analysis. Furthermore, the fuzzy analysis seems to be more appropriated when the stochastic process that models the uncertainties is unknown. The simulation results of the fuzzy analysis procedure are confined to the time domain response, being generated by the fuzzy dynamical response of the smart composite structure when fuzzy uncertain parameters are considered. This numerical study illustrates the versatility and convenience of the mentioned fuzzy analysis to evaluate how the uncertain parameters affect in the dynamical response of the smart composite materials.

keywords: Modeling, Numerical Simulation and Optimization, Nonlinear Dynamics and Complex Systems, Stochastic Models.

DISCRETE ELEMENTS ON PARALELL MULTI-CORE USING DYNAMIC PARTICLE FLOW SIMULATIONS TO EXAMINE FRESH CONCRETE AND SLUMP TEST PARAMETERS

Luiz Carlos Facundo Sanches[1], *Ronaldo Carrion*[2], *Carlos Héracles Moraes de Lima*[3]

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Abstract: This paper examines the behavior of fresh concrete numerically. When fresh, the concrete is considered as a fluid which exhibits nonlinear behavior. In fact, establishing a model for predicting the plastic viscosity of concrete based on its composition will be extremely valuable for the industry. Lately, numerous constitutive equations and reliable numerical schemes have been proposed to characterize the rheology of fresh concrete as suspensions. Additionally, parallel algorithms and constitutive models can be combined with existing engineering implementations already used to study fluid dynamics. Particularly, the Discrete Element Method (DEM) has been commonly employed to simulate particle flows, though it is becoming a popular method to represent discontinuous medium as well. In that regard, it is worth mentioning that there even exist architectures for multi thread parallel computation of DEM for processing acceleration, while still making effective use of the available memory. This work investigates the feasibility of using parallel computing DEM on Personal Computer (PC) multi-core processors to assess the fresh concrete flow problem. Herein, we compare numerical results against experimental values. Regarding the experiments, the slump test is typically employed to assess the consistency of fresh concrete. As well as to check that the correct amount of water has been added to the mix. The concrete is then put into a work-form, which is suddenly released so that the concrete spreads under the gravity loading. With the standard slum test, only the final value of the slump is measured. For our purposes, the spreading and slump have been recorded as a function of time: different slumping and pouring visualizations has been also used. The slump observations indeed illustrate the capability of the model to describe concrete flow. Previous results suggest a speedup for the utilized parallelization schemes and good agreement with experimental measurements.

keywords: Modeling, Numerical simulation, Fluid dynamics, Parallel Discrete Element Method, Fresh concrete.

TALKS

Using neuroimaging techniques to reveal the brain complex networks at rest

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Abstract: Measuring cerebral activity with advanced neuroimaging techniques has been a useful approach to explore the complex functional organization of the brain. In this talk we will review the main neuroimaging techniques currently employed to assess cerebral activity during the resting state. In particular, we will present our most recent results on using functional Magnetic Resonance Imaging (fMRI) and near-infrared spectroscopy (NIRS) to assess the spontaneous activity of the human brain during the resting state.

keywords: Complex Networks, Nonlinear Dynamics and Complex Systems, Time Series Analysis.

ANALYTICAL BIFURCATION TREES OF PERIODIC MOTIONS TO CHAOS IN A PERIODICALLY DRIVEN PENDULUM

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Abstract: In this paper, periodic motions to chaos in a periodically driven pendulum are analytically predicted through the discrete implicit maps. This analytical prediction of stable and unstable periodic motions is completed through the corresponding mapping structures of specific periodic motions in the periodically forced pendulum. Stable and unstable periodic motions and chaos in the bifurcation trees are analytically obtained, and the corresponding stability and bifurcation analysis of periodic motion are completed through eigenvalue analysis. Finally, numerical simulation results of various periodic motions are illustrated for motion complexity in the periodically forced pendulum. The analytical prediction of bifurcation trees of periodic motions to chaos gives a global view of motion changes from a specific periodic motion to another one..

keywords: Bifurcation Analysis and Applications, Chaos and Global Nonlinear Dynamics, Nonlinear Dynamics and Complex Systems

Bifurcation and Shock Wave Solutions of Burgers Equation

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Abstract: The paper investigates the bifurcation behavior and shock wave occurrence of the inviscid Burgers equation with the initial condition,u(x, 0) =f(x), where x ∈ (0, 1) and t > 0, f (x) = A sin Bx (A, B > 0 are parameters). The Burgers equation with this periodic initial condition shows that some initial continuous input in a continuous nonlinear system may result discontinuous outputs. The paper theoretically proves that there exists multiple solutions for each x ∈ (0, 1) and for some t, in some range of parameters A and B. It also proves the existence of discontinuous solution (shock wave) for some x and t. In addition, the paper gives an estimate about the number of multiple solutions. More general initial conditions and the viscid Burgers equation are also studied.

keywords: Bifurcation Analysis and Applications, Chaos and Global Nonlinear Dynamics, Fluidodynamics, Plasma and Turbulence.

SET STABILITY OF FIXED POINTS FOR DISCRETE MAPS

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Abstract: In discrete event systems, such as the logistic map is possible to find points that converge to a fixed point, said to be unstable by the classical definition of stability. However the classic definition derived from continuous-time systems based on the idea of the region, where all present points converge to the equilibrium point, but if there is a point within this region that does not converge to the equilibrium point, it is said be unstable. As soon as the idea of the region relates to a continuous thing, so is pertinent to hypothesize that a definition more consistent of stability for discrete systems would be to set of stability, as would a set of points that lead to a fixed point and not a region . For example, if the function has no fixed point, there is an empty set; the set has only fixed point is that the fixed point is unstable.

keywords: Discrete Dynamical Systems, Chaos, Numerical Simulation.

SET STABILITY OF FIXED POINTS FOR DISCRETE MAPS

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Abstract: In discrete event systems, such as the logistic map is possible to find points that converge to a fixed point, said to be unstable by the classical definition of stability. However the classic definition derived from continuous-time systems based on the idea of the region, where all present points converge to the equilibrium point, but if there is a point within this region that does not converge to the equilibrium point, it is said be unstable. As soon as the idea of the region relates to a continuous thing, so is pertinent to hypothesize that a definition more consistent of stability for discrete systems would be to set of stability, as would a set of points that lead to a fixed point and not a region . For example, if the function has no fixed point, there is an empty set; the set has only fixed point is that the fixed point is unstable.

keywords: Discrete Dynamical Systems, Chaos, Numerical Simulation.

PRIVATIZATION AND GOVERNMENT PREFERENCE IN A BERTRAND MODEL

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Abstract: We will consider a mixed Bertrand duopoly model (that means, two firms decide simultaneously their prices for a homogeneous good) to study the relationship between the privatization of a state-owned public firm and government preferences for tax revenue. In the model, we assume that the government imposes a specific tax rate on the quantity produced by each firm. Furthermore, the public firm aims to maximize social welfare, whereas the government's objective function is weighted sum between social welfare and tax revenue. Of course, the private firm aims to maximize its own profit. We also present comparative static results.

keywords: Modeling, Optimization, Industrial Organization, Game Theory.

PRICE-SETTING MIXED TRIOPOLIES

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Abstract: We will consider two models describing certain market structures: (i) a domestic market in which a public firm (whose objective is to maximize social welfare) competes with two private firms (whose objective is to maximize their own profits); and (ii) an international market in which a domestic public firm competes with one domestic private firm and one foreign private firm. In both situations, firms decide simultaneously the price for their complementary goods.
The main purpose of the paper is to present and to compare the equilibrium outcomes of the two triopoly models.

keywords: Modeling, Optimization, Industrial Organization, Game Theory.

Nonlinear Dynamics of an Origami Structure Coupled to Smart Materials

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Abstract: Origami structures have instigated studies in various areas of knowledge (since the medical field, with applications in minimally invasive surgery, to aerospace, to make use of solar panels for satellites). Self-expanding structures (or self-folding), obtained from origami concepts, require small actuators to transition between shapes assumed by the structure. In the case of structures that restrict its own motion, characteristic belonging to origami-wheel, it is sufficient to use a few actuators. This paper deals with the dynamic analysis of the behavior of an origami-wheel actuated by smart materials with thermal-mechanic couple, analyzing the response of the structure to external forces and thermal variations and evaluating the dynamic behavior of the system. The origami-ball has strong geometric and constitutive nonlinearities presenting a complex dynamical response.

keywords: Nonlinear Dynamics, Analysis of Nonlinear Dynamical Systems, Practical Applications of Nonlinear Systems, Origami structure, Smart Materials

Nonlinear suboptimal controller design for chaotic motions of mobile robot formations

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Abstract: In this work a nonlinear controller design problem for a multiple nonholonomic robot leader-follower formation performing a desired chaotic trajectory is formulated and solved. This problem has several applications in both civil and military fields, such as exploration of terrain in search of explosives or dangerous materials and patrolling for intruders. The basic idea of this scheme consists in one robot that is selected as leader and therefore is responsible for guiding the formation. The other robots, called followers, are required to track the position and orientation of the leader with some prescribed offsets. In this paper, the leader robot is set to follow a Duffing strange attractor trajectory and follower robots are set to perform synchronization to a specified distance from leader. To control the dynamic system, State Dependent Riccatti Equation (SDRE) control method is applied in order to solve this nonlinear control problem yielding a suboptimal state feedback controller. This control method was chosen because it takes into account the nonlinearities of the problem, thus avoiding linearization and loss of complexity. Numerical simulations demonstrate the effectiveness of the SDRE-based feedback control.

keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Control of Chaos, Synchronization in Nonlinear Systems.

3DBMO: A TIME SERIES CANONICAL GENERATOR TO STUDY THE PSD DIMENSIONAL DEPENDENCE IN COMPLEX PHYSICAL SYSTEMS

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Abstract: The study of density, magnetic and electric field fluctuations in real systems, such as nonlinear processes in the solar, magnetospheric and ionospheric environments, is generally analyzed using Power Spectrum Density (PSD) which is calculated from one-dimensional data in the form of time series. In this work we present a new simulation device of multi-dimensional harmonic mechanical oscillations (we call 3DBMO) for generate robust time series from selected elements, where the spectral analysis is used to determine the hypothesis of dependence variation of the power spectrum according to the structure of the generated system. The importance of this study is discussed into the context of complex physical systems as nonlinear oscillators, fluids and plasmas, to which the correspondent dynamics is usually characterized by using PSD and related scaling exponents.

keywords: Complex Dynamics, Time Series Analysis, Coupled Oscillators System, Modeling, Numerical Simulation and Optimization.

PARAMETRIC EXCITATION OF OFFSHORE RISER USING REDUCED-ORDER MODELS BASED ON BESSEL-TYPE MODES: CALIBRATION OF HYDRODYNAMIC COEFFICIENTS

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Abstract: The effects of the added mass and mean drag coefficients on the post-critical transversal vibrations of the mathematical model of an offshore riser are discussed, when it is subjected to parametric excitation induced by harmonic axial displacements at the top. A single degree-of-freedom non-linear reduced-order model is obtained from the continuum-beam equation of motion, using Bessel-type modes. After numerical integration, using a Runge-Kutta scheme, maps of post-critical amplitude are presented in function of the amplitude and frequency of the parametric excitation. Results are confronted with the standard analysis that usually assumes both hydrodynamic coefficients to be constant.

keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications; Bifurcation Analysis and Applications; Modeling, Numerical Simulation and Optimization; Reduced-order model; Parametric excitation

Numerical imprecision and its impact on discrete systems as Logistic Map

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A striking feature that occurred in chaotic systems is the sensitivity to initial conditions that are typically observed through numerical methods, but how is the situation when the tool we use to view the chaotic behavior interferes with results due to their inability to accurately represent an inserted initial condition, and this happens and can be viewed on the logistic map, where you have to $r = 4$ and initial condition equal to ¾, which is also a fixed point, and with this is obtained analytically convergence for this fixed point on the first iteration and this remains when performed more iterations analytically, however this is not checked on the computer after a few iterations inserts an error that implies divergence due to this fixed point being in a bowl of chaotic attraction. However this can be avoided if a methodology that evaluates the error at each iteration is employed.

keywords: Discrete Dynamical Systems, Chaos, Numerical Simulation.

Nonlinear free vibrations of shear deformable beams with axially movable boundary conditions

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Abstract:
The nonlinear free oscillations of a planar Timoshenko beam with axially movable boundary conditions are studied, by adding an axial spring at one hand in order to simulate the effect of an elastic constraint with stiffness κ. Since the exact solution is not available, two different approximate solutions are compared (analytical and numerical). The comparison is made in terms of backbone curves for both solutions. Attention is focused on the effect of the beam slenderness, by considering both slender and stubby beams, and on the effect of the ending spring stiffness κ, with values between zero and infinity. A very good agreement between the two solutions is highlighted, together with their reliability.

keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Nonlinear Dynamics and Complex Systems, Nonlinear Dynamics of Systems with Infinite Dimension, Timoshenko beam, Nonlinear oscillations, Asymptotic Methods, Backbone Curve.

Estimation of pitch period in voice signals using Poincare section

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Abstract: Researchers reported voice instability in children voices due to anatomic and physiological changes in laryngeal structures. Acoustic parameters may be an effective and non-invasive way to voice assessment. The aim of this paper is to detect the Fundamental frequency F0 of healthy children voices using Poincaré Section technique (PST). The statistic T – test indicates that measures of F0 using PST are compatible with those obtained with Fourier transform at the default 5% significance level. Results indicate that PST is a promising tool for F0 analysis with the advantage of determining a fundamental frequency even in high nonlinear and non-periodic signals.

keywords: Time Series Analysis, Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Synchronization in Nonlinear Systems, Poincare Section, Nonlinear analysis.

FRACTIONAL-ORDER MODELS FOR VEGETABLE TISSUES

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Abstract: We use electrical impedance spectroscopy to determine the impedance spectra of vegetable leaf samples. We fit fractional-order empirical models into the experimental data. We verify that a 4-parameter model characterizes assertively the leaf species.

keywords: Nonlinear Fractional Dynamics and Applications, System Biology, Modeling, Numerical Simulation and Optimization.

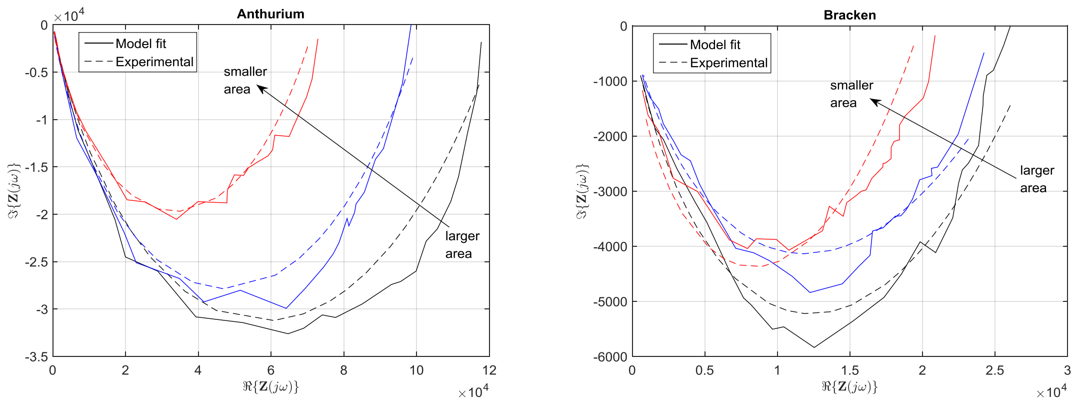
Leaves are most responsible for food production in vascular plants. They exhibit a large variety of shapes and sizes, and often are classified according to their form, or based on the arrangement of their veins [1]. The study of individual leaves can reveal important characteristics of the whole plant, namely the nutrient concentration, the presence of diseases, tissue damage and rooting ability, among others [1-2].
Electrical impedance spectroscopy (EIS) has been widely used for studying vegetable tissues [1-5]. EIS measures the electrical impedance of a specimen across a given range of frequencies, producing a spectrum that represents the variation of the impedance versus frequency [1-2].
In practical terms, EIS involves exciting the specimen under study by means of electric sinusoidal signals and registering the system response. This technique has the advantage of avoiding aggressive examinations. A considerable volume of research addresses this topic when dealing with vegetable materials, namely roots, leaves, stems, vegetables and fruits [1-9].
Given an impedance spectrum of experimental data, the main question is to find a mathematical model that fits well to the data and has minimum number of parameters [10-11]. As biological tissues are complex systems characterized by dynamic processes that occur at different lengths and time scales, we need models that adequately describe the behavior of such materials by considering the interactions among the various relaxing phenomena and memory effects. Different empirical models, developed in the context of the so-called dielectric relaxation phenomena have been used to achieve that purpose, namely the Cole-Cole (CC), Cole-Davidson (CD) and Havriliak-Negami (HN) models [12-14]. Even though the original formulations are empirical and do not use fractional derivatives or integrals, explicitly, they may be regarded as pioneer applications of fractional calculus (FC). Such connection has been addressed by several authors [15-16].
In this paper the impedance spectra of leaf samples from two distinct plants are determined by means of EIS. FC empirical models are then fitted into the experimental data. The chosen plants, namely the Bracken (*Pteridium aquilinum*) and the Anthurium (*Anthurium andraeanum*) have leaves with very different shapes.
We start by measuring the electrical impedance in the frequency range $f = 10$ Hz up to $f = 1$ MHz, at $N = 30$ logarithmically spaced points. We then fit the FC models into the experimental data in order to minimize a distance criterion, J, between the experimental and model impedance polar diagrams. A standard genetic algorithm (GA) is adopted, with elitism, crossover within all population and 5% mutation probability [17].
Experiments demonstrated that the HK model of equation (1) leads to the best fit.

$$G(j\omega) = \frac{K}{\left[1 + \left(\frac{\omega}{\omega_p}\right)^{\alpha}\right]^{\beta}} \tag{1}$$

Table 1 summarizes the optimal parameters obtained for six specimens analyzed. The experimental and approximated curves are depicted in Figure 1 in the form of polar plots. We verify that the values of K and ω_p vary with the leaf size, while α and β remain almost invariant. On the other hand, we observe that α and β characterize assertively the plant species.

Table 1: FC model parameters calculated by the GA algorithm.

Leaf specimen		Area (mm^2)	K	ω_p	α	β	J
Bracken *Pteridium aquilinum*		22848	28395.56	30190.56	0.376	2.109	0.178
		14184	27929.71	43807.77	0.297	2.551	0.142
		4857	19839.88	267357.11	0.432	2.456	0.326
Anthurium *Anthurium andraeanum*		11591	122965.77	1742.80	0.558	1.296	0.191
		4878	101670.76	2957.08	0.593	1.314	0.271
		2281	71862.53	3350.45	0.593	1.314	0.415



(a) (b)

Fig. 2: Polar plot of the impedance $\mathbf{Z}(j\omega)$ for two leaves with three different sizes for: (a) Bracken; (b) Anthurium.

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A Dynamical Approach to Time Series with Fluctuating Statistical Parameters

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Time series distributions in complex physical systems may show strong deviations from Gaussian statistics which can be understood as a superposition of different dynamics with well separated time scales. In this interpretation, Gaussian statistics holds on short time scales as a quasi-equilibrium distribution with parameters that change on larger time scales. Averaging over these fluctuating parameters with a suitable statistical model yields a compounding that provides a description of non-Gaussian distributions of physical observables, such as velocity increments in turbulent flow. This scheme, known in physics as superstatistics, has had great successes in describing phenomena as diverse as turbulence in classical fluids [1], microwave propagation through disordered cavities [2] and price variations in financial time series [3-4]. Recently [5], an interesting multiscale extension of superstatistics was introduced by studying the stationary solution of a hierarchy of coupled stochastic differential equations (EDE) which achieved good agreement with experimental data on classical turbulence. In this work we extend this EDE approach in two ways: (i) we focus on time-lagged increment distributions, as opposed to marginal stationary distributions; (ii) we account for long time-lagged Gaussian asymptotic behavior in the increment distributions by inserting time-dependence on some EDE parameters. In addition, we provide a novel procedure to extract the time series of the fluctuating parameter of the short-time Gaussian statistics, which describes well heavy-tailed long-time compounding distributions. Our numerical results show good qualitative agreement with experimental data on Eulerian turbulence.

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- **keywords**: Time Series Analysis, Stochastic Models, Turbulence.

CHARGE BEHAVIOR ANALYSIS IN BALL MILLS BY USING TORQUE SIGNAL

An alternative to increase the efficiency of ball mills

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Abstract

Ball mills can be frequently found in ore grinding facilities. These machines show high energy consumption together with low energy efficiency. As a consequence, a small improvement on the performance of the grinding process can have a huge impact in the operating costs of the plant and in the optimization of energy resources. Therefore, the aim of this paper is to present a method to analyze the dynamic of the charge in a ball mill, with focus on the filling level. The method is based on analysis of the torque signal behavior. The proposed method does not use sensors installed directly on the mill, it requires only the signals available for motor control purposes in frequency inverter drives. The torque signal senses directly the excitation signal (impacts on the shell). Due to the grinding process to be considered a complex, nonlinear, time delay and time-varying system, a non-linear load torque observer to estimate the fill level is used. Then, the energy efficiency is evaluated. The control and monitoring of the system is accomplished by supervisory software (SCADA), and the analysis and signal processing by using Matlab via OPC communication. In order to check the validity of the method a comparison is carried out with the signal obtained from a dynamometer coupled to the mill shaft, since the charge motion disturbs the motor shaft torque. The current signal behavior is also checked.

keywords: Analysis and Control, Complex System, Nonlinear Dynamical System, Load torque, Ball mill.

High-Order Numerical Approach for Computational Model of the Pressureless Gas Dynamics Equations

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Abstract: A wide variety of physical phenomena are governed by mathematical models of the pressureless gas dynamics (PGD) type. An important class of problems of practical interest that a dispersed phase is transported within a continuous fluid phase includes domains of multiphase combustion, liquid water droplets in atmosphere and alumina particles in rocket engines, as well as pollutant particle dispersion or cosmology. Those particle flows with high Knudsen number result in the zero pressure of gas dynamic equations. The main features of resulting PGD equations are occurrences of delta function and vacuum. In general, both of delta function and vacuum are well predicted using the existing Godunov-type upwind schemes. Those schemes have been however developed for the governing equations that satisfy the strictly hyperbolic conservation law. For the non-strictly hyperbolic conservation law, those schemes may not be proper due to a lack of distinct eigensystem. This results in a major numerical difficulty of PGD equations, by the reason, special schemes like as a kinetic approximation, sticky particle or discontinuous Galerkin approaches have been extensively studied to overcome those numerical difficulties. Another attractive way to solve the PGD equations is to use relaxation models for applying the Godunov-type upwind schemes. In general, the relaxation models can be taken into account for adding artificial terms multiplied by a very small constant value in the PGD equations. Thus, the relaxation models cannot maintain a same mathematical form with the PGD equations. Nevertheless, the computational models for solving the PGD equations still involve numerical issues with respect to a robustness of solutions. It can be mentioned as a positivity of density in a vacuum. Without proper positivity-preserving schemes, the density may become negative, which is unphysical. As a consequence, it becomes one of critical factors for developing the proper numerical schemes. Thus, the positivity-preserving property of numerical schemes plays a key role to accurately resolve nonlinear wave regions. For instance, the flux vector splitting schemes are known to be free from this drawback. The scheme however suffers an intrinsic incompatibility between the desirable positivity-preserving property and the accurate resolution of contact discontinuities. The Roe-type flux difference scheme is known that the positivity-preserving property is not guaranteed. The Harten-Lax-van Leer scheme can be served as a positivity-preserving scheme by the absolute values of the maximal and minimal wave speeds satisfying certain stability bounds.

In this study, a simple computational model for the PGD equations is proposed by taking an advantage of the relaxation model that can utilize the approximate Riemann solver. An artificial term multiplied by a very small constant value is added in the left- and right-hand sides of the PGD equations in order that the model maintain a same mathematical form with respect to the PGD equations. In fact, the artificial term added in both sides is motivated by a simple technique based on splitting of the original mathematical system into the well-posed hyperbolic part and the source term. Even if the computational model satisfies the strictly hyperbolic property, there still remains a question of whether the Godunov-type upwind schemes can be developed to meet the positivity-preserving property and guarantee accuracy near the singularities. For a treatment of the following questions, the HLLC scheme including the depth positivity conditions is applied to the computational model. It also serves as the basic building block to apply the Weighted Essential Non-Oscillatory scheme involving a simple flux limiter for numerical stabilities. In the simple flux limiter, a first order flux scheme is replaced to the HLLC scheme instead of the Lax-Friedrichs scheme for simplicity of building block in the present framework. Lastly, numerical results of one- and two-dimensional test problems are presented for the computational model and flux limiter.

keywords: Fluid Dynamics, Numerical Simulation, Computational Modeling, HLLC, Flux Limiter

FIRST RETURN TIMES TO APPROXIMATED GENERATING PARTITIONS OF INDUCED DUFFING MAP

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Abstract: Chaotic dynamical systems produce information at a rate given by the Kolmogorov-Sinai entropy. This information can be analysed by coding a chaotic trajectory by a (semi-)infinite symbolic sequence obtained from a suitable partition of the system's phase space. Such partition, called generating partition, must provide a different and unique coding for each trajectory of the system. To each (semi-)infinite sequence composed of infinitely many repetitions of the same block with p symbols there is a p-periodic orbit associated. Since the set of unstable periodic orbits embedded in a chaotic attractor is denumerable, the generating partition can be systematically determined by coarse graining the phase space into cells and labeling each cell with the symbol associated to its nearest unstable periodic orbit. As the number of unstable periodic orbits considered increase and the size of the cells decrease a better approximation to the generating partition is obtained. This strategy is applied in this work to estimate the generating partition of the (T-iterated) induced Duffing map (IDM, for short) in chaotic regime. First, the set of all unstable periodic orbits up to period T were determined by the method proposed by Schemelcher and Diakonos. Then, the generating partition of the T-th iterate of IDM was estimed for several cell sizes and different metrics. In each case, we determine approximations to the Kolmogorov-Sinai entropy of the IDM by computing the Shannon entropy of typical symbolic sequences obtained from these partitions. Moreover, we consider the Baladi-Eckmann-Ruelle approximation to construct a zeta function for the transfer operator of IDM from the statistics of first return times of typical trajectories to these partitions. The Lyapunov exponents of IDM were computed by locating the smallest zero of this zeta function. Finally, we show that our results are roughly independent of the choice of cell size and maximum period considered.

keywords: Chaos and Global Nonlinear Dynamics, Nonlinear Dynamics and Complex Systems, Modeling, Numerical Simulation and Optimization

LAGS OF PROMETHEUS AND PANDORA

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Abstract: Observational data obtained during Saturn's ring plane crossing of 1995 indicated angular lags for the predicted positions of Prometheus and Pandora. Using additional observational data the lags were confirmed, with Prometheus about 19 degrees ahead and Pandora about 25 degrees behind their predicted longitudes. Chaotic motion associated to a 121:118 mean motion resonance between the two satellites is the theory currently accepted to explain these lags. In the present work we return to this problem proposing that an analysis of the temporal evolution of the semi-major axis of the satellites in order to explain the lags. Due to the secular interaction between the satellites their apsidal lines are periodically anti-aligned every 6.2 years, producing close encounters between the two bodies. During these moments there is a stronger interaction that produces variations in their semi-major axis. The main point is that the data used to propagate the orbits of the satellites was obtained near to the moment of one of these close approaches.

keywords: Celestial Mechanics and Dynamical Astronomy, Modeling, Numerical Simulation and Optimization, Nonlinear Dynamics and Complex Systems.

Frequency synchronization in power-grid models of Kuramoto-like oscillators

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Abstract: Recent studies have shown that stability and robustness in power grids can be studied by means of conceptual models that use oscillator models derived from the swing equation for electrical generators and machines connected through network structures that reproduce dynamical phenomena arising in real power-grids. A great deal of interest resides in the comprehension of the mechanisms leading to transitions between synchronous and incoherent states, the latter being characterized by the emergence of undesired situations in real power-grids, such as load shed and generation trip. In this sense, the so-called Kuramoto-like oscillator with bimodal distribution was studied on the basis of analytical and numerical methods that considered network topologies corresponding to those of real high-voltage transmission systems, from which dynamical parameters for the persistence of synchronization in the face of perturbations and nontrivial relations between dynamical and topological parameters were provided. A number of other studies also use Kuramoto-like models to study synchronization and stability issues in power-grids. The key point here is that these models are argued to capture the essential dynamical and structural properties allowing the identification of fundamental mechanisms and properties that matter for stability and robustness purposes, which can be matched to those emerging in real power-grids. In the context of power-grid models based on Kuramoto-like oscillators, synchronization is defined as the matching of the angular velocities of the oscillators, such that synchronized oscillators evolve most likely out of phase but with equal angular velocities over time. As such, coherence is usually measured by means of an order parameter in the interval [0,1], which is a function of synchronization quality and persistence over time. In this paper, we present analytical results on the critical coupling for synchronization in networks of Kuramoto-like oscillators. On the basis of the maximization of the phase deviation angle over the coupled oscillators, we seek for the minimum coupling that can provide synchrony. The analytical results are evaluated against an order parameter defined as the normalized sum of absolute values of phase deviations of the oscillators over time. The investigation of frequency synchronization over subsets of the parameter space of the synchronization problem for power-grid models of Kuramoto-like oscillators is carried out, from which we conclude that the analytical results are in good agreement with those observed in the numerical simulations. As a final remark, we note that the proposed approach allowed the study of synchronization in power-grid models in a consistent and meaningful way and it may help enhance the comprehension of power-grid dynamics in upcoming studies.

keywords: complex networks, bifurcation analysis and applications, synchronization in nonlinear systems.

Different population of hypothetical objects in the Pluto system and the New Horizons mission

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Abstract:

Pluto and Charon form a binary system, and since 2011 four small satellites were added to this particular system. These satellites, Styx, Nix, Kerberos and Hydra, are located exterior to Charon's orbit. During the close approach with the Pluto system in July 2015, the New Horizons mission sent several images showing the surface of the binary system and the small satellites. However, the total amount of data will be sent in the next years.

In this work we intend to analyse several stable regions found between the orbits of Pluto and Charon, and also beyond Charon's orbit for objects of different sizes, since tiny dust particles to km-sized objects. The analysis of these stable regions was carried out through a sample of numerical simulations, taking into account different kinds of population: i) test dust particles, where the effects of the solar radiation pressure were taken into account; ii) cm-sized test particles; and iii) km-sized objects. In this case, the gravitational effects of these objects on the satellites of Pluto were assumed. Our results show that a peculiar stable region was found between the orbits of Pluto and Charon where hypothetical cm-sized bodies can be located in periodic and quasi-periodic orbits. Smaller particles, under the effects of the solar radiation pressure, and km-sized objects, under the gravitational perturbation of the binary, have a very short period of time. Our results also showed the radial location of the densest part of this region that could be imaged by the New Horizons mission.

Beyond Charon's orbit, several regions were found between the satellites' orbits and coorbital to them. Ours results, concerning km-sized objetcs, constrained the location and size of hypothetical satellites that can be found by the New Horizons cameras. Dust particles, released by the surface of the small satellites, could form a very tenuous ring around Pluto. However, it will be difficult to detect this ring, even for the New Horizons instruments.

keywords: Celestial Mechanics and Dynamical Astronomy, Dinâmica Não Linear e Sistemas Complexos, Chaos and Global Nonlinear Dynamics.

EXTENDING NUMERICAL SOLUTIONS OF POTENTIAL FIELDS METHOD BASED ON BOUNDARY VALUE PROBLEMS FOR 3D ENVIRONMENTS

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Abstract: The aim of this article is to present a extension to a 3D environment from a motion planning method, oriented potential fields, used to 2D environments. To the best of our knowledge, such extension is a novel method itself.

This method will allow the use of autonomous robots, such as Unmanned Aerial Vehicles (UAVs) to move in a complex environment with dynamical obstacles.

Both sequential and parallel implementations were developed to evaluate the impact of such approaches.

keywords: Modeling, Numerical Simulation and Optimization; Control in Complex Systems; Analysis and Control of Nonlinear Dynamical Systems with Practical Applications.

WATERSHED DELINEATION - INVERSE PROBLEM AND STOCHASTIC APPROACH

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Abstract: The direct problem in runoff modeling is to determine the direction of flow that every drop of water will have to rush into an area of known digital elevation model. The set of all terrain points that drain water that it can precipitate to a common point, called outlet, determines the watershed upstream of such outlet. In this article, the definition of Watershed is presented as an Inverse Problem, and a Stochastic Approach is proposed: enabling the direction of flow is not unique in every precipitation events, and therefore the Watershed is represented as a map indicating the probability of each point of the ground part of the set. The collaborative HydroC library is used as a basis for the implementation of the codes (numerical method) originally developed for this investigation. Probabilistic results (analitical method) are obtained based on the theorem of total and conditional probability. The results show that the Watershed related to the classical approach (deterministic) may not even be the modal configuration of the distribution of different Watershed configurations.

keywords: Stochastic Models, Nonlinear Dynamics and Complex Systems, Fluidodynamics, Plasma and Turbulence

Community detection using coupled Kuramoto oscillators with conditional repulsion

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(Underline the name of the author whom will present the paper)

Abstract: Complex Networks have been presented ubiquitously in the last decade. As a straightforward and efficient framework to represent agents and their relationships, several fields, from Physics to Sociology, have taken advantage of the representation power provided by complex networks. A particular feature inherited by almost any real world network is the presence of groups of densely connected nodes, named modules, clusters or communities. The community organization of the network can provide valuable information about the network, such as the network domain and its organization. In this work, we present a novel model based on coupled Kuramoto oscillators with positive and negative links. Opposing to prior applications of coupled Kuramoto oscillators to detect communities, here we propose a conditional negative coupling that depends on the topological features of selected nodes. By using this new negative coupling, we obtain a more efficient model without degrading the community detection accuracy since, at the dynamical equilibrium, the oscillators will not be all at the same phase as if the standard Kuramoto model is applied, nevertheless, within modules, the phases will tend to be very similar, which allows us to easily detect the existing modules in the complex network.

keywords: Complex Networks, Nonlinear Dynamics and Complex Systems, Synchronization in Nonlinear Systems, Community Detection.

Signal Propagation in Axons

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Abstract:
Axons, although often thought of as mere cables through which electrical impulses travel, may in fact be actively involved in the encoding of neuronal information. Here, we study axonal action potential initiation, propagation and collision using a multi-compartment model based on the Hodgkin-Huxley equations. We characterize propagation speed, refractory period, excitability and action potential collision for slow (type I) and fast (type II) axons. In addition, our studies include experimental measurements of action potential propagation in axons of two biological systems that are consistent with our numerical simulation results.

keywords: Nonlinear Systems and Neural Dynamics, System Biology, Nonlinear Dynamics and Complex Systems, Axonal .

Control of extreme events in the bubbling onset of wave turbulence

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Abstract: We show the existence of an intermittent transition from temporal chaos to turbulence in a spatially extended dynamical system, namely, the forced and damped one-dimensional nonlinear Schrödinger equation. For some values of the forcing parameter, the system dynamics intermittently switches between ordered states and turbulent states, which may be seen as extreme events in some contexts. In a Fourier phase space, the intermittency takes place due to the loss of transversal stability of unstable periodic orbits embedded in a low-dimensional subspace. We mapped these transversely unstable regions and perturbed the system in order to significantly reduce the occurrence of extreme events of turbulence.

keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications; Fluidodynamics, Plasma and Turbulence; Nonlinear Dynamics of Systems with Infinite Dimension.
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A new second order local time scheme for numerical simulations of evolutionary partial differential equations with localized physical phenomena.

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Abstract: Techniques for numerical simulations of localized complex physical phenomena may require a lot of CPU time, making the solution unavailable in a reasonable time. To improve it adaptive methods are used. They consist in using an automatic mesh adapted to the solution locally. To improve this challenge when explicit method are used in time, a local second order in time approach is proposed. It consist in using for each cell an individual time step proportional to its refinement, respecting the CFL condition locally. For that synchronization steps must be done. Some verification tests on CARMEN code are presented, where we show that the CPU time and precision of the solutions are improved compared to usual schemes.

keywords: Numerical Simulation and Optimization, Fluidodynamics, Geophysical Nonlinear Dynamics.

The Characteristic Based Split scheme applied to solve the Navier-Stokes equations.

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Abstract: In this work is applied the classical method of finite elements, known as Bubnov-Galerkin method (GFEM), applied to simulate two-dimensional incompressible steady and transient flows. The GFEM is considered the best method for solving purely diffusion problems, however, in case of problems with convection dominant as in many problems of fluid flows, the GFEM produces oscillating solutions. So, the main purpose of this paper is to show how this method associated with the Characteristic Based Split scheme (CBS) deals with the nonlinearity of Navier-Stokes equations to smooth those oscillations. To achieve that, some problems with geometries commonly used to validate the computational code was studied and the results shows excellent agreement with the literature pointing that this method is effective.

keywords: Fluidodynamics, Numerical Simulation, Nonlinear Dynamics in Fluid Sciences, Finite Elements, CBS.

On the verification of an adaptive three-dimensional magnetohydrodynamic model

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Abstract: The magnetohydrodynamics (MHD) is an important tool to study the dynamics of the plasma in Space Physics. In this context, we introduce a 3D-MHD solver with divergence-cleaning in the adaptive multiresolution (MR) CARMEN code. This code uses finite volume method that ensures the conservation of physical quantities and the MR approach, that allows the automatic identification of local structures in the numerical solution. The last provides an adaptive mesh refined only where the solution needs more resolution. The goal is to verify the 3D-MHD CARMEN code in comparing its results with the ones from the well known FLASH code.

keywords: Fluidodynamics, Plasma and Turbulence, Modeling, Numerical Simulation and Optimization , Geophysical Nonlinear Dynamics , Magnetohydrodynamics, Adaptive Multiresolution Analysis.

Detecting dynamical changes in data streams

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Abstract: Nature processes are typically non stationary, many of them exhibit chaos. In some situations, the changes in their behavior represent the most interesting event. A natural way of analyzing such data is by the study of phase space trajectories over time. In this study, we employ concepts from Data Streams, a subarea of Machine Learning, for detecting such dynamical changes. The proposed algorithm is capable of dealing with data continuously produced at high rates. Experiments with synthetic confirm our approach detects dynamical changes on nonlinear and non stationary data with noise added.

keywords: Nonlinear Dynamics and Complex Systems, Chaos and Global Nonlinear Dynamics, Time Series Analysis, Data Streams.

Stationarity breaking in biological coupled physical systems in mice sleep revealed by recurrence analysis

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Abstract: Stationarity breaking is a normal phenomena in real systems but such detection can be quite tricky. In this work we will show a specific biological system in which this kind of transition can be evaluated by recurrence analysis. The recurrence analysis is a nonlinear tool based on Poincaré concept of recurrence, and is intended to study time series doing extractions of essential features from the recurrence plot (**RP**) matrix. More specifically we do the evaluation of temporal series obtained from sensors attached to mice, which one of it capture physical movement signals (namely accelerometer signal or **Acc**) and another was invasive attached to hippocampus cerebral region (hippocampus signal or **Hpp**). With the use of recurrence quantification analysis (**RQA**) tools, will be shown that the sleep stage SWS in mice have a characteristic curve shape regarding the analysis of determinism (**DET**) in both signals. Also will be presented that there is a subtle modification on the accelerometer series just before micro-arousal detection by the recurrence quantifier applied to this physical movement data, and that this event is anti-phase synchronized with the determinism signal from invasive hippocampus data. Finally, will be discussed the importance and the perspective due this intrinsic relation between both biological signals and the consequences of this signature in SWS rodent signals.

keywords: Time Serie Analysis, System Biology, Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Micro-Arousal and Stationarity Breaking.

Features of edge-centric collective dynamics in machine learning tasks

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Abstract: Several models of collective dynamics have been applied to many Machine Learning tasks, specially in pattern recognition tasks of data classification and clustering. Those models employ concepts from natural systems which the decentralized behavior of the interacting parts produces dynamics with useful global patterns. The self-organizing feature of these dynamics enables us to acquire complex global information using simple local evolution functions. Ant colonies, flocking behavior of birds, and competition/cooperation within and between species are examples of natural systems applied in optimization and learning problems. The Edge Domination System is an algorithm to obtain information of the underlying complex network through patterns revealed by the dynamics of a system based on particle competition. The model input is an undirected, unweighted network with a small set of labeled vertices. Unlike related approaches found in the literature, the interacting elements (particles) compete for the edges of the network. Three simple action rules govern the particle dynamics: walking, absorption, and generation. A labeled vertex generates labeled particles which will all randomly walk and compete for domination of the edges. The number of visits of particles equally labeled determines the domination level. Particles passing through edges dominated by rivals may be absorbed, that is, removed from the system. The system output consists of sets of edges arranged by the dominating label. Each group of edges tends to be a connected subnetwork. Each subnetwork may represent a class of data in the learning problem. The model was successfully applied in transductive inference for semi-supervised learning problems. However, it was not clear to us how different the model is from a model which the domination occurs on vertices. We compare our edge-centric model with a similar model, adapted for vertex domination. Thus, in this paper, we present a vertex-centric version of the model and a comparison between the edge- and vertex-centric models. We argue the edge-centric model can provide more information about the data topology than the vertex version while both models have the same order of time and space complexity. The additional information should increase performance on pattern recognition tasks. We also demonstrate and study the distinct behavior of both models in overlapping regions, that is, vertices or subnetworks that share more than one class label. However, we compare both models' performance and come to an unexpected conclusion to us. The classification mechanism for edge-centric model proposed in our previous work still does not take full advantage of the topological information provided by the edges. Consequently, classification results for both approaches — competition in vertices and edges —, are very similar.

Keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Complex Networks, Nonlinear Dynamics and Complex Systems, Collective Dynamics and Particle Competition, Machine Learning.

BUILDING PHASE SYNCHRONIZATION EQUIVALENCE BETWEEN COUPLED BURSTING NEURONS AND PHASE OSCILLATORS

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Abstract: Bursting neurons are characterized by an alternation of active and inactive state, in the active state they exhibit train of spikes and no response during the inactive state. When bursting neurons are coupled the beginning of their active state can synchronize depending on the coupling strength. If the coupling strength is increased above a critical coupling value, their active state show a transition from a partial synchronization, where just few neurons are synchronized, to a complete synchronization, in which all the neurons begin their active state in the same time. This transition has the same type observed in coupled phase oscillators. Adjusting the frequency distribution of the oscillators properly, it is possible to represent bursting neurons as coupled phase oscillators to describe phase synchronization.

keywords: phase synchronization, bursting neurons, oscillators, nonlinear systems and neural dynamics.

Excitatory and Inhibitory Synapses in Coupled Model Neurons

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Abstract: We use model equations to study the effects of excitatory and inhibitory synaptic connectivities in a network of two neurons, in a variety of firing regimes. Our results are dependent on the dynamics of the individual neurons, and on the type and strength of the coupling. Bifurcation diagrams illustrate the intricate dynamics associated with the many possibilities for the two neurons for synchronization in the case of excitatory coupling, or competition in the case of inhibitory coupling. This study is of particular interest for central pattern generators, which are neuron networks that produce vital rhythmic motor outputs such as those observed in mastication, walking and breathing, for example.

keywords: neural, synchronization, model.

(**At least the first three keywords must be chosen among the following ones:**

- Analysis and Control of Nonlinear Dynamical Systems with Practical Applications
- Bifurcation Analysis and Applications
- Celestial Mechanics and Dynamical Astronomy
- Chaos and Global Nonlinear Dynamics
- Climate Dynamics
- Complex Networks
- Control in Complex Systems
- Control of Chaos
- Discontinuous Dynamical Systems
- Epidemiology and Mathematical Models
- Fluidodynamics, Plasma and Turbulence
- Geophysical Nonlinear Dynamics
- Modeling, Numerical Simulation and Optimization
- Nonlinear Dynamics and Complex Systems
- Nonlinear Dynamics in Lasers
- Nonlinear Dynamics in Thermal and Fluid Sciences
- Nonlinear Dynamics of Systems with Infinite Dimension
- Nonlinear Fractional Dynamics and Applications
- Nonlinear Systems and Neural Dynamics
- Stochastic Models
- Synchronization in Nonlinear Systems
- System Biology
- Time Series Analysis

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A delayed p53 ubiquitination induced via c-Myc-ARF interaction pathway

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P53 is one most studied molecule in cancer research. It plays pivotal roles in controlling cell cycle, cancer progression etc. It interacts with various cellular molecules either indirectly or directly. So far, various studies have shown the behavior of the p53 in various cell types. But still there is scope to study its molecular behavior in different biological pathway or systems. Various studies reported that MDM2 is an antagonist of p53. MDM2 directly interact with p53 protein. Moreover, MDM2 ubiquitinates p53 protein concentration level in the systems. c-Myc is a very small molecule which can interact with MDM2 via p14ARF.

In the present work we model a c-Myc controlled MDM2-p53 interaction molecular network. A deterministic model has been established for this pathway. Next, a mathematical description of the pathway is also provided. We numerically simulate this model using 4th order Runge-Kutta method. Simulation results which we obtained clearly indicate that c-Myc delayed decay of p53 concentration level in the systems. It also indicates p53 protein concentration level can be maintained in the systems via c-Myc. We found different cellular states viz. normal, sustained, steady states which correspond to different cellular phases i.e unstressed, stressed, stable or apoptotic respectively. Similarly, chemical langevin equation is also solved for this interaction. The numerical simulation of chemical langevin equation also provides some stochastic behavior of the model. Our theoretical results are also congruence with various experimental results. Further, stochastic approach is needed to understand the clear picture of the behavior.

Keywords: Nonlinear Dynamics and Complex Systems, Modeling, Numerical Simulation and Optimization, System Biology, c-Myc, p53.

The influences of the companion for the formation of the Gamma-Cephei planetary system

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Abstract: The Gamma-Cephei system is a binary system formed by two massive stars, Gamma-Cephei A and its companion Gamma-Cephei B and a planet called Gamma-Cephei b, which has a S type orbit around Gamma-Cephei A, perturbed by Gamma-Cephei B. This kind of system has attracted attention due to the short separation between the stars, around 20 AU, which is, up to now, the shortest distance for a binary separation hosting a planetary system. In this work we simulated a protoplanet with the core already formed focusing in the final stages of gas accretion, searching for initial conditions capable to reproduce the current orbital elements and mass of Gamma-Cephei b. Our simulations was performed using the hydrodynamical code FARGO 2D.
keywords: Dynamical Astronomy, Fluidodynamics, Numerical Simulation, Planetary Formation.

Lyapunov spectrum of chaotic maps with a coupling mediated by a diffusing substance

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Abstract: Nonlocal couplings consider the interaction of each site with all its neighbors, but take into account the lattice distance between them. Kuramoto has shown that such couplings occur among point oscillators mediated through a diffusing chemical substance. In other words, each oscillator secrets a mediator substance with a rate proportional to the oscillator dynamics. This substance diffuses in the intersite medium and its local concentration also influences the dynamics of the oscillators. In the case of a very fast diffusion the coupling strength decreases with the lattice distance in an exponential way. This diffusion-mediated coupling model has been used to describe bursting synchronization in neuronal networks and circadian rhythms in the suprachiasmatic nucleus. The Lyapunov spectrum is a useful tool in the investigation of many dynamical properties of a coupled map lattice, since it yields information about the stability of the completely synchronized state. There are some techniques for the numerical obtention of Lyapunov exponents of a coupled map lattice. In some cases it is even possible to obtain analytically this spectrum, as we did in previous works dealing with power-law couplings. In this work we obtain the Lyapunov spectrum of coupled chaotic map lattices with non-local couplings obtained through the mediation of a chemical substance diffusing rapidly in the space. The calculation can be done analytically for maps with constant slope. This gives information about the regions of synchronization for such a coupled map lattice.

keywords: complex networks, nonlinear dynamics and complex systems, synchronization in nonlinear systems

Synchronization of phase oscillators with coupling mediated by a diffusing substance

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Abstract: Networks of coupled phase oscillators have been extensively used in many physical and biological applications. A number of different coupling prescriptions has been studied, but most attention has been given to two types: local coupling, where each oscillator interacts with its nearest neighbors; and global coupling, where an oscillator is coupled to the mean field of all other oscillators regardless of their position. However, in many applications it turns out that an intermediate form of coupling would better describe the system, since each oscillator interacts with its neighbors but with a strength which depends on the mutual spatial distance. Such non-local couplings have been studied for a long time but recently it was recognized their importance in the production of chimera states. One of the interesting dynamical aspects to be studied in networks of non-locally coupled phase oscillators is synchronization, which is a universal phenomenon. A paradigmatic example of them is the synchronization of flashing fireflies, which interact by the emission of light pulses. Since the velocity of light is very large, the coupling effect is rapidly spread along the network and fireflies can flash in unison, producing an impressive phenomenon. On the other hand, emission of light pulses is not the only way oscillators can use to communicate among themselves. Another possibility is the emission and absorption of a chemical substance which diffuses in the medium containing the oscillators. A theory for describing such phenomena has been proposed by Kuramoto, and in the case of fast relaxation it amounts to an interaction which decays exponentially with the distance between oscillators. In this work we consider a model of point-like phase oscillators which interact according to this non-local coupling prescription. We investigate in what extent the frequency synchronization properties vary with the coupling parameters. It turns out that there is a synchronization transition with properties depending on both the coupling strength and range.

keywords: complex networks, nonlinear dynamics and complex systems, synchronization in nonlinear systems

Spatio-temporal dynamics and pattern formation in a two-dimensional reaction-diffusion model with non-local interactions

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Abstract: We considered a two-dimensional version of a reaction-diffusion model (due to Meinhardt and Gierer) describing pigmentation in animal skin, for which the interactions are non-local, i.e. they consider the effect of distant neighbors, the contribution decreasing with the lattice size. We analyzed the linear stability of the spatially homogeneous pattern in order to describe the Turing instability and investigated numerically pattern formation in the system.

keywords: Chaos and Global Nonlinear Dynamics, Complex Networks, Nonlinear Dynamics and Complex Systems

Hurst exponent estimation of self-affine time series through a complex network approach

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Abstract: Many natural signals present a fractal-like structure and are characterized by two parameters, β, the power-spectrum power-law exponent, and H, the Hurst exponent [1]. For time series with a self-affine structure, like fractional Gaussian noises (fGn) and fractional Brownian motions (fBm), the Hurst exponent H is one of the key parameters.

Over time, researchers accumulated a large number of time series analysis techniques, ranging from time-frequency methods, such as Fourier and wavelet transforms [2, 3], to nonlinear methods, such as phase-space embeddings, Lyapunov exponents, correlation dimensions and entropies [4]. These techniques allow researchers to summarize the characteristics of a time series into compact metrics, which can then be used to understand the dynamics or predict how the system will evolve with time [5]. Obviously, these measures do not preserve all of the properties of a time series, so there is considerable research toward developing novel metrics that capture additional information or quantify time series in new ways [5, 6, 7]. One of the most interesting advances is mapping a time series into a network, based on the concept of transition probabilities [5]. This study has demonstrated that distinct features of a time series can be mapped onto networks (here called quantile graph or QG) with distinct topological properties. This finding suggests that network measures can be used to differentiate properties of fractal-like time series.

In spite of the large number of applications of complex networks methods in the study time series, usually involving the classification of dynamical systems or the identification of dynamical transitions [8], establishing a link between a network measure and H remains an open question [1]. Recently, a linear relationship between the exponent of the power law degree distribution of visibility graphs and H has been established for noises and motions [9,10].

Here, we show an alternative approach for the computation of the Hurst exponent [1]. This new approach is based on a generalization of the method introduced in Ref. [5], in which time series quantiles are mapped into nodes of a graph. In this approach, a quantile graph is obtained as follows: The values of a given time series is coarse-grained into Q quantiles $q_1, q_2, \ldots, q_Q$. A map M from a time series to a network assigns each quantile q_i to a node n_i in the corresponding network. Two nodes n_i and n_j are connected with a weighted arc n_i, n_j, w_{ij}^k whenever two values x(t) and x(t + k) belong respectively to quantiles q_i and q_j, with t = 1, 2, . . . ,T and the time differences k = 1, . . . , k_{max} < T. Weights w_{ij}^k are given by the number of times a value in quantile q_i at time t is followed by a point in quantile q_j at time t+k, normalized by the total number of transitions. Repeated transitions through the same arc increase the value of the corresponding weight. With proper normalization, the weighted adjacency matrix becomes a Markov transition matrix. The resulting network is weighted, directed and connected. Besides, the QG method is numerically simple and has only one free parameter, Q, the number of quantiles/nodes [1, 5].

The QG method for estimating the Hurst exponent was applied to fBm with different H values. Based on the QG method described above, H was then computed directly as the power-law scaling exponent of the mean jump length performed by a random walker on the QG, for different time differences between the time series data points [1]. Results were compared to the exact H values used to generate the motions and showed a good agreement. For a given time series length, estimation error depends basically on the statistical framework used for determining the exponent of a power-law model [1].

Therefore, the QG method permits to quantify features such as long-range correlations or anti-correlations associated with the signal's underlying dynamics, expanding the traditional tools of time series analysis in a new and useful way [1,5].

keywords: nonlinear dynamics and complex systems, time series analysis, complex networks, Hurst exponent, quantile graphs.

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REACTIVE MODEL FOR CONVERGENCE OF ACTIVE AGENTS TO MOVING FORMATIONS

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Abstract: Collective motion emerges from interactions among individuals as observed in nature with flocks of birds and schools of fish. The rules that govern these interactions can be extended to artificial units (active agents) like mobile robots. In this work, we elaborated a reactive model to lead groups of autonomous mobile agents to moving formations, starting from random positions. In this model, the agents interact via repulsion, alignment and attraction rules, and do not keep memory of previous interactions. The result is a parallel formation of agents moving in a desired direction.

keywords: Nonlinear Dynamics and Complex Systems, Control in Complex Systems, Synchronization in Nonlinear Systems, Collective Motion, Multiagent Systems.

Estimation of Dynamical Phase Models for Chaotic Oscillators

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Abstract: Despite the advances in synchronization theory, a complete understanding about the synchronous regions of chaotic oscillators is still lacking. Dealing with periodic oscillators, one of the most successful approaches is the phase description method, where a dynamical model is obtained to describe the evolution of the phase of the system. Conclusions about synchronous regimes of the system (e.g. Arnold tongues) can be estimated by analyzing only the phase model. This work presents an attempt to extend this approach to chaotic oscillators, by means of modelling its phase dynamics, based on the evolution of the states. Phase models for the Rössler and Lorenz systems were estimated from data using system identification techniques. The paper investigates the feasibility of choosing the most adequate variable for coupling oscillators by analyzing the phase model – structure and parameters. This could lead to a more systematic way of investigating *aspects of synchronizability*. Analysis about observability and controllability of the phase model is also addressed.

keywords: Synchronization in Nonlinear Systems, Modeling, Numerical Simulation and Optimization, Control in Complex Systems.

Stochastic dynamics with multiplicative noise: An analysis on time reversibility.

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Abstract:

In this work, we study equilibrium properties of stochastic differential equations with multiplicative noise. We use a general prescription α for considering the stochastic integration and we also represent the stochastic process in a functional Grassmann formalism. We carefully define a time reversal transformation taking into account that the asymptotic stationary probability distribution depends on the prescription. We show that, using a careful definition of equilibrium distribution and the appropriate time reversal transformation, usual equilibrium properties are satisfied for any prescription.

keywords: Stochastic Models, Nonlinear Dynamics and Complex Systems, Modeling, Numerical Simulation and Optimization

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MULTIOBJECTIVE OPTIMIZATION APPLICATION IN DOE PROBLEMS WITH MULTIPLE RESPONSES

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Abstract: In many areas, from Engineering to Economics, problems present themselves as multiobjective, which makes a decision-making process complex. Generally, these are conflicting objectives, and optimization techniques are necessary to achieve better results. This paper applies agglutination methods in classical problems of design of experiments with multiple responses. A theoretical review was made, and a new method was developed, using Compromise Programming and Goal Programming, with results comparison and analysis. The new proposal presented better results when compared to the traditional approach, qualifying this procedure as an alternative in multiple responses optimization.

Keywords: Epidemiology and Mathematical Models, Modeling, Numerical Simulation and Optimization, Nonlinear Systems and Neural Dynamics, Goal Programming, Compromise Programming.

Dynamical potentials for non-equilibrium stationary states driven by multiplicative stochastic processes

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(Dated: February 16, 2016)

Stochastic processes with multiplicative noise often leads to stationary out-of-equilibrium states. They are characterized by the presence of probability currents and, in general, time-reversal is a broken symmetry and usual equilibrium properties, such as detailed balance, are not satisfied. In this type of stationary states, symmetry-breaking phase transitions could take place, induced by noise[(a)]. That is, for weak noise the stationary state is usually disordered. However, an ordered state sets in when the noise intensity is increased. There are two necessary ingredients to produce this class of phase transitions: multiplicative noise and out-of-equilibrium stationary states[(b)].

In this work, we present a study on out-of-equilibrium phase transitions induced by multiplicative noise. Recently, we have presented a functional formalism[(c,d)] to compute correlations functions in these systems. Based on that, we built up a "dynamical potential" written in terms of an order parameter capable to describe non-equilibrium phase transitions.

As an example, we applied our formalism to a particularly simple model which captures the physics of non-equilibrium phase transition. The model is defined by a set of stochastic variables arranged in a hyper-cubic lattice satisfying a system of interacting Langevin equations with multiplicative noise, where we consider first neighbors interactions. We computed a "dynamical potential" for the stationary state in the saddle-point plus Gaussian fluctuations approximation. We have built up a phase-diagram in terms of the lattice interaction and the noise. We discovered a phase transition with reentrant behavior for sufficiently strong lattice coupling. We computed the phase diagram for different dimensions and for different values of the stochastic prescription that defines the multiplicative stochastic process. At the level of this approximation we found that the phase transition is continuous and we computed critical exponents. Even thought, the concept of universality is not completely developed in out-of-equilibrium transitions, the computed exponents are in the universality class of the dynamical Ising model.

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KeyWords: Stochastic processes, multiplicative noise, non-equilibrium stationary states, phase transitions.

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Conditional Lyapunov Exponents for Izhikevich Neuronal Model

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Abstract: The Izhikevich (IZ) neuronal model has been adopted as a benchmark in theoretical neuroscience, and exhibits one of the best relations between biological plausibility and computational cost. The present work aims to analyze the synchronism of unidirectional coupled IZ neurons by means of the conditional Lyapunov exponent evaluation. In order to overcome the analytical difficulties imposed by its discontinuous structure, we apply a saltation matrix theory to the variational equations. The generalization of this results for unidirectional and bidirectional couplings in electrical and chemical contexts is been conducting.

Keywords: Discontinuous Dynamical Systems, Nonlinear Systems and Neural Dynamics, Synchronization in Nonlinear Systems, Conditional Lyapunov exponents, Izhikevich model

Spectral properties of temporal evolution of brain network structure

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Abstract: Temporal evolution properties of brain network was known to be crucial to complex brain processes. In this paper, we investigate the difference of dynamic brain network for resting and visual stimulation states in task-positive subnetwork, task-negative subnetwork and whole brain network. The dynamic brain network is first constructed from human fMRI data based on sliding window method, and then the eigenvalues corresponding to the network is calculated. We use eigenvalue analysis method to analyze the global properties of eigenvalues, and adopt random matrix theory (RMT) method to measure the local properties. For global properties, we found that the shifting of eigenvalue distribution and degrease of the largest eigenvalue are linked to visual stimulation in all networks. For local properties, the short-range correlation in eigenvalues measured by nearest neighbor spacing distribution is not always sensitive to visual stimulation. However, the long-range correlation in eigenvalues evaluated by spectral rigidity and number variance not only predicates the universal behavior of dynamic brain network, but also suggests the non-consistent changes in different networks, The results prove that the dynamic functional network is more random for task-positive subnetwork and whole brain network at visual stimulation state, but is more regular for task-negative subnetwork. Our findings help to gain deeper insights into the importance of spectral properties to functional brain network, especially stress out the incomparable role of RMT on revealing the intrinsic properties of complex system.

keywords: fMRI, dynamic brain functional network, spectral properties, RMT

QUALITY DENOISING HEART SIGNAL EXPERIMENTALLY ACQUIRED

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Abstract: Heart is complex dynamic system essential to life. Careful analysis of this system permits detection of clinical problems, and characterization of response to stimuli. Electrocardiogram capture the electrical impulses generated by the heart on the skin surface. Due to extremely low amplitude of this signal, the interference of breath, muscle movement, and electromagnetic noise, it is difficult to get a signal / noise ratio suitable for data analysis, requiring signal cleaning. As highlighted filtering technique wavelet transform. This job specifying electrical signal of the heart, showing signal acquired, and comparing the results of filtering techniques that ensure signal quality to identify specific details.

keywords: Time Series Analysis, System Biology, Nonlinear Dynamics and Complex Systems.

The postgraduate Brazilian studies in Physics Teaching using Complex Network

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Abstract: In this paper we study the topological structure of a semantic network based on keywords from thesis and dissertations on Brazil's Physics Teaching in the decade of 1996-2006. The results obtained were through some indices of social and complex networks. We analyzed the vertices with higher degree of centrality (hubs) we have inferred that the work carried out showed a pattern in terms of chosen keywords, indicating a preference for words associated with the training of physics teachers. The found topology of studied semantic networks are small-world and scale-free.

keywords: Complex Networks, Control in Complex Systems, Modeling, Numerical Simulation and Optimization, Social Network, Physics Teaching.

Chaotic Properties of the Hénon Map with a linear filter

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Abstract: An interesting way of limiting the bandwidth of the transmitted signal in a chaos-based communication scheme is to use linear discrete-time filters in the feedback loop. It was recently proved that such filters do not disturb chaotic synchronization. However, there is no guarantee that the generated signals remain chaotic. In this paper, we consider the Hénon map plus a linear time-invariant finite impulsive response filter. We numerically access its larger Lyapunov exponent as a function of the filter coefficients, obtaining regions where chaotic, periodic or unbounded orbits are present.

keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Nonlinear Dynamics and Complex Systems, Discrete Dynamical Systems, Time Series Analysis.

A switching scheme between conventional and chaos-based communication systems

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Abstract: Many communication systems based on the synchronization of chaotic systems have been proposed as an alternative spread spectrum modulation that improves the level of privacy in data transmission. However, due to the lack of robustness of complete chaotic synchronization, even minor channel impairments are enough to hinder communication. In this paper, we propose an encoding function for chaos based communication systems that can assure the generation of chaotic signals. Moreover, the encoding function parameters can be adjusted so that the transmitted signal can range from a conventional communication signal to a chaotic one, presenting sensitive dependence on initial conditions. Based on this function, we present an adaptive equalization scheme that allows us to recover the transmitted sequence in different non-ideal scenarios. In spite of the advantages of the proposed system when using chaotic signals, the performance in terms of bit error rate is poor in comparison with a conventional communication system without chaos. Inspired by Wireless Fidelity (Wi-Fi) technology, which switches the modulation depending on the communication channel quality, we propose an algorithm to switch between the chaos-based communication system and the conventional one. The switching is triggered based on a threshold applied to the mean square decision error (MSE). In the proposed system, if MSE is greater than -35 dB, the conventional communication system is used. On the hand, when the channel conditions get better and MSE becomes lower than -35 dB, the system returns to the chaotic regime. Preliminary simulation results show that the switching and equalization algorithms can successfully recover the transmitted sequence in different scenarios.

keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Chaos and Global Nonlinear Dynamics, Synchronization in Nonlinear Systems.

On the Karin family

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Abstract: The Karin cluster is a young asteroid family thought to have formed only ~5.75 My ago. The young age can be demonstrated by numerically integrating the orbits of Karin cluster members backward in time and showing the convergence of the perihelion and nodal longitudes (as well as other orbital elements). Previous work has pointed out that the convergence is not ideal if the backward integration only accounts for the gravitational perturbations from the Solar System planets. It improves when the thermal radiation force known as the Yarkovsky effect it is accounted for. This argument can be used to estimate the spin obliquities of the Karin cluster members. Here we take advantage of the fast growing membership of the Karin cluster and show that the obliquity distribution of diameter D~1-2 km Karin asteroids is bimodal, as expected if the YORP effect acted to move obliquities toward the extreme values (0^o or 180^o). The measured magnitude of the effect is consistent with the standard YORP model. The surface thermal conductivity is inferred to be 0.07-0.2 W $m^{-1}K^{-1}$ (thermal inertia ~300-500 J $m^{-2}K^{-1}s^{-1/2}$). We find that the strength of the YORP effect is roughly ~0.7 of the nominal strength obtained for a collection of random Gaussian spheroids. These results are consistent with a surface composed of rough, rocky regolith. The obliquity values predicted here for 480 members of the Karin cluster can be validated by the light-curve inversion method.

keywords: Celestial Mechanics and Dynamical Astronomy, Stochastic Models, Time Series Analysis.

On the oldest asteroid families in the main belt

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Abstract: Asteroid families are groups of minor bodies produced by high-velocity collisions. After the initial dispersions of the parent bodies fragments, their orbits evolve because of several gravitational and non-gravitational effects, such as diffusion in mean-motion resonances, Yarkovsky and YORP effects, close encounters of collisions, etc. The subsequent dynamical evolution of asteroid family members may cause some of the original fragments to travel beyond the conventional limits of the asteroid family. Eventually, the whole family will dynamically disperse and no longer be recognizable.

A natural question that may arise concerns the timescales for dispersion of large families. In particular, what is the oldest still recognizable family in the main belt? Are there any families that may date from the late stages of the Late Heavy Bombardment and that could provide clues on our understanding of the primitive Solar System? In this work, we investigate the dynamical stability of seven of the allegedly oldest families in the asteroid main belt. Our results show that none of the seven studied families has a nominally mean estimated age older than 2.7 Gyr, assuming standard values for the parameters describing the strength of the Yarkovsky force. Most ``paleo-families'' that formed between 2.7 and 3.8 Gyr would be characterized by a very shallow size-frequency distribution, and could be recognizable only if located in a dynamically less active region (such as that of the Koronis family). V-type asteroids in the central main belt could be compatible with a formation from a paleo-Eunomia family.

keywords: Celestial Mechanics and Dynamical Astronomy, Stochastic Models, Time Series Analysis.

LAGRANGIAN DYNAMICS OF SEPARATION BUBBLE IN ITS EVOLUTION FROM GENERATING TO BREAKING

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Abstract: For the flow around a body in turbo-machinery and aerospace engineering, the breaking of separation bubble is the main route to vortex shedding, which is a complex unsteady flow. More, it has an important influence on the aerodynamic performance of blade and airfoil near stall. Recently, experiments show that some kind separation bubbles and their breakings, which are induced by some unsteady perturbations or excitations, can lead to the improvement of the aerodynamic performance in a sense. In other words, such improvement is relevant to the generating, developing and breaking of separation bubble. However, the nature for such phenomenon is still open, and hence it is necessary to study the evolution of the bubble breaking in depth.

In this paper, Lagrangian Coherent Structures (LCS) introduced to study the breaking of separation bubble in the flow around airfoil with low Reynolds number, from viewpoint of nonlinear dynamics. In particular, the transitions are analyzed in detail, and then the mass and momentum transfers are studied further.

The results show that there exists a transition from steady flow to unsteady flow, as the breaking of separation bubble occurs. For such unsteady flow, the traditional Eulerian description is no longer available to describe the dynamics, which is related to mass and momentum transfers. To this end, LCS is used to describe the Lagrangian dynamics and the Lagrangian pattern is captured. Then, the mass and momentum transfers are studied in the breaking of separation bubble, following pattern dynamics. Finally, the mass and momentum transfer in the evolution of bubble are investigated following the LCS, and the influence of breaking of bubble on the aerodynamic performance is studied.

The results show that the breaking of separation bubble can lead to unsteady flow, and such unsteady flow can be controlled efficiently to improve the aerodynamic performance for the flow around body.

keywords: Fluid dynamics, Plasma and Turbulence, Nonlinear Dynamics and Complex Systems, Nonlinear Dynamics of Systems with Infinite Dimension, Nonlinear Dynamics of Systems with Infinite Dimension.

PARTICLE TRAJECTORIES DRIVEN BY DRIFT-WAVES IN SHEARED FLOWS

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Abstract: Particles driven by drift wave fluctuations are numerically computed to describe the transport at the tokamak plasma edge [1, 2]. We assume the large aspect ratio approximation and investigate the effects due to the sheared electric and magnetic equilibrium profiles in a **E x B** flow. The influence of toroidal plasma rotation in the transport is introduced by assuming the parallel velocity profile in a kinetic model of guiding-center of motion. Particle trajectories are obtained by the symplectic maps derived from the canonical motion equation. We investigate the particle trajectories when combining the parallel velocity profiles with monotonic and non-monotonic safety factor profiles. Chaotic transport at the plasma edge can be reduced by properly modifying the electric and magnetic shears [3]. For non-monotonic radial electric field profile, non-twist transport barriers are identified by extremum values of the rotation number profiles of the invariant curves. The shearless curve allows the trapping chaotic trajectories into the plasma and can be displaced by the magnetic and velocity shears. In addition, particle transport shows strong dependence on parallel velocity.

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keywords: Plasma and Turbulence, Analysis and Control of Nonlinear Dynamical Systems, Nonlinear Dynamics and Complex Systems.

CHARACTERIZATION OF INHOMOGENEOUS TURBULENCE FROM FLUCTUATIONS OF DENSITY AND ELECTROMAGNETIC FIELDS IN SPACE PLASMAS

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Abstract: Most processes with complex dynamics in space physics are related to the mechanism of turbulence. We present a new method (the *MS-space*) to characterize the underlying energy cascade in *p-model* turbulent processes. From the analysis of fluctuations using both multifractal and non-gaussian scaling exponents we show that it is possible to build the MS-space where the central area represents a homogeneous energy cascade (h-region). Examples of deviations from the *h-region* indicate a non-homogeneous energy cascade. Density fluctuations analysis in the ionosphere, solar corona and galactic fields are shown as striking examples.

keywords: Topics: Fluidodynamics, Plasma and Turbulence; Nonlinear Fractional Dynamics and Applications; Time Series Analysis.

(**At least the first three keywords must be chosen among the following ones:**

- Analysis and Control of Nonlinear Dynamical Systems with Practical Applications
- Bifurcation Analysis and Applications
- Celestial Mechanics and Dynamical Astronomy
- Chaos and Global Nonlinear Dynamics
- Climate Dynamics
- Complex Networks
- Control in Complex Systems
- Control of Chaos
- Discontinuous Dynamical Systems
- Epidemiology and Mathematical Models
- Fluidodynamics, Plasma and Turbulence
- Geophysical Nonlinear Dynamics
- Modeling, Numerical Simulation and Optimization
- Nonlinear Dynamics and Complex Systems
- Nonlinear Dynamics in Lasers
- Nonlinear Dynamics in Thermal and Fluid Sciences
- Nonlinear Dynamics of Systems with Infinite Dimension
- Nonlinear Fractional Dynamics and Applications
- Nonlinear Systems and Neural Dynamics
- Stochastic Models
- Synchronization in Nonlinear Systems
- System Biology
- Time Series Analysis

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EIGENVALUE ANALYSIS OF A SIMPLE FLEXIBLE ROTOR

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Abstract: There are several methods available to solve the eigenvalue problem for a rotor system. In this work the finite element formulation of a simple rotor system is performed. After that, the subspace interaction method is applied to calculate the Natural Frequencies, which are obtained for different numbers of elements. Finally the results are compared between the various discretization performed and also with the Jeffcott rotor.

keywords: Dynamical Systems, Modeling, Numerical Simulation.

A MONTHLY STREAMFLOW FORECASTING MODEL USING BAYESIAN INFERENCE THEORY

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Abstract: Electrical power generation is related to the economic development of nations and dependent upon the availability of natural resources. While there are several energy sources available in Brazil, according to the Brazilian Electricity Regulatory Agency (ANEEL), water is responsible for about 61.45% of electrical power generation. This is due to Brazil's geography and weather, resulting in factors which favor the formation of river resources, making Brazil among the countries with the highest hydroelectric potential. The amount of available water is quantified by streamflow, which is important not only for power generation, but also for irrigation, fishing, shipping, tourism, agriculture, etc. Streamflow is influenced by several factors, such as relief, coverage of river basins, precipitation and soil type, and others. Analysis and forecasting of streamflow time series data are important in the operational planning of water resources systems. One of the greatest difficulties in forecasting such data is the seasonal nature of streamflow as well as exceedingly wet and dry periods throughout the year.

Many of the activities associated with the planning and operation of water resources systems depend on forecasting streamflow. In particular, there is a need for short and long-term streamflow forecasting techniques to feed simulation or optimization models. Many hydroelectric systems are large in terms of spatial dimensions and have hydrometric data collection networks that are very sparse. Such conditions can result in considerable uncertainty in the hydrological information that is available. Furthermore, the inherently non-linear relationship between input and output variables complicates attempts to forecast streamflow events. Another difficulty in the forecasting of this data is the nonstationary nature of streamflow series data resulting from wet and dry periods of the year. Due to the complexity of the water flows and random aspects of the data there is a need for models that are able to represent a satisfactory level of accuracy in streamflow behavior. The literature suggests several models such as artificial neural networks, Box and Jenkins models, among others.

Bayesian theory is based on Bayes' theorem and is characterized by the use of previous information, known as *a priori* information, which is responsible for characterizing the knowledge we have on the parameter of interest prior to the experiment or collection of observational data. There are some advantages to using Bayesian inference: such as the simplicity in the interpretation of information as it relates to *a posteriori* probability, or the absence of assumptions about the models and the possibility of including uncertainty in the construction of an *a posteriori* distribution. These factors make it possible to obtain more accurate estimates for model parameters. Simply put, Bayesian approaches provide forecasts with fewer errors and more accuracy on streamflow problems.

This paper proposes streamflow forecasting models based in regressive techniques with Bayesian approaches for two plants in Rio Grande (Furnas and Marimbondo power plants). The streamflow data used belongs to the Electric System National Operator and corresponds to the period from 1931 to 2013. The obtained results were satisfactory and are in accordance with acceptable levels stipulated by the Brazilian Power Sector. Results were compared with other approaches and found promising with respect to one-step ahead forecasting.

keywords: Streamflow Forecasting, Power Systems Planning, Bayesian Inference, Forecasting Model.
Main Topic: Time Series Analysis

COMPARATIVE STUDY OF SHORT-TERM LOAD FORECASTING MODELS

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Abstract: Monitoring of the electrical load on a power system is a basic requirement in operating and planning. To provide electrical power with good quality, i.e., safe and economical way, an electrical company must have mechanisms that enable the resolution of various technical and operational problems. In order to obtain an improvement in the planning and control system, new optimization tools are developed and applied, with significant results in reducing costs of operation. For this, the knowledge of the load behavior is the first prerequisite for a safe and reliable planning of the power system.

Operating program of a hydrothermal power system establishes the average output of each power plant for each time interval of the next day. Obviously, the total production in each time interval should meet the estimated demand for the respective time interval. Specifically in the context of short-term power systems operation, the load forecast is important to prepare the operation program of the next days because a small error in the load forecast may have serious consequences in terms of system efficiency. In this context, a good prediction is essential because it seeks to meet demand, increasing efficiency and system reliability.

Load forecasting is a typical time series forecasting problem and it is a traditional research topic in the power systems area. Initially the forecasting models were based on statistical models and was the dominant technique until the mid-80's. After, with the emergence of artificial neural networks most of the proposed models for load forecasting is using this technique. In recent years, various techniques have been proposed for the prediction problem and including models based on neurofuzzy networks. They have presented the highest quality results, emerging as a very interesting alternative to the problem of time series forecasting.

The main objective of this paper is to evaluate the performance of the neural, neurofuzzy and statistical models in the short-term load forecasting problem. To perform this analysis models were adjusted to find better adjustment for the load time series used. The results obtained showed that the neural models and neurofuzzy models showed greater robustness when applied to load time series with a lower standard deviation, however when the load data has higher standard deviation the statistical models tend to present more accurate results.

keywords: Short-Term Load Forecasting, Power Systems Planning, Support Vector Machines Artificial Neural Networks, Forecasting Model.

Main Topic:

- Time Series Analysis

A SHORT-TERM LOAD FORECASTING MODEL BASED IN SUPPORT VECTOR MACHINES

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Abstract: Short-term load forecasting is essential information for the operation an electric power system. Decision making in operation planning, real-time operation, and security analysis depend of the quality on the load demand forecast. Forecasting with high precision make it possible to optimize the production and the operation of the electrical system. Accurate models for electric power load forecasting are essential to the operation and planning of a utility company. Load forecasting is used by energy management systems to establish operational plans for power stations and their generation units. They are also necessary for energy suppliers, financial institutions, and other participants in energy generation, transmission, distribution, and markets.

In the literature, it is possible to find, for short-term load forecasting, techniques constructed using traditional statistical methods such as ARIMA Box & Jenkins. Nowadays, alternative approaches for load forecasting improved. They include the artificial intelligence research field, from which we may highlight the Artificial Neural Networks (ANN), whose main advantage is based on the fact that the knowledge is extracted from a database without needing previous knowledge about the model. This knowledge is a function of some stimuli, properly applied to the neural network, which constitutes the training phase. Machine Learning algorithms, such as support vector machines (SVMs) have been considered a promising alternative, to traditional methods for regression or for classification. Extending this technique to deal with regression problems, the SVM approach has been considered highly competitive, and it is possible to highlight the applications involving time-series forecasting.

However, the SVM applicability has been hampered by the necessity of choosing *a priori* the following: (i) the kernel function (responsible for the mapping); (ii) the kernel function optimal parameters (in charge of kernel configuration in accordance with the given application data), (iii) the loss function (penalty function) and (iv) trade-off parameter C (controls the trade-off between closeness to the data and term gauge smoothness).

The main objective of this paper is to apply SVMs, analyzing various kernels, to predict the active electrical load of a 24h period of the next day. The effectiveness of the proposed approach is demonstrated on a Brazilian electric utility. The SVMs approaches were configured in distinct ways to check the robustness in solving the proposed problem. Finally, a comparison between the SVM and ANN approaches was made, and the conclusion was that the SVM approach had slightly better performance than the ANN in most of cases.

keywords: Short-Term Load Forecasting, Power Systems Planning, Support Vector Machines Artificial Neural Networks, Forecasting Model.

Main Topic:

- Time Series Analysis

COMPLEX NETWORK INTO GEOGRAPHICAL INFORMATION SYSTEMS

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Abstract:
Geographic Information Systems allow geographic data visualization and handling of geographical data, as traffic zone vectors (polygons adopted as a unit of urban mobility study) and hydrography (set of water courses in a region). The data structure representation of complex networks (set of nodes and edges representing a complex system) can be made considering, for example, the traffic zone centroids as the nodes, connected each other in accord of people flow, and river's headwater and outlet as the nodes and water courses as edges. The current work shows a computational schema to a complex network representation in a Geographic Information System.

keywords: Complex Networks, Geographic Information Systems, Urban mobility, Hydrography

Collective dynamics in two populations of noisy oscillators with asymmetric interactions

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We study two intertwined globally coupled networks of noisy Kuramoto phase oscillators that have the same natural frequency, but differ in their perception of the mean field and their contribution to it. Such a give-and-take mechanism is given by asymmetric in- and out-coupling strengths which can be both positive and negative. We uncover in this minimal network of networks intriguing patterns of discordance, where the ensemble splits into two clusters separated by a constant phase lag. If it differs from π, then traveling wave solutions emerge. We observe a second route to traveling waves via traditional one-cluster states. Bistability is found between the various collective states. Analytical results and bifurcation diagrams are derived with a reduced system.

Keywords: Synchronization in Nonlinear Systems, Complex networks, Nonlinear Dynamics and Complex Systems.

Supernovae Automatic Classification Method by Modeling Human Analysis using Artificial Neural Networks

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Abstract: Classify a recently discovered supernova is not trivial and only a few experts astronomers are able to perform it. The existing automatic classifiers did not do the modeling of the human way of analyzing the spectrum to classify supernovas. They only compares the spectrum similarity of discovered supernova with spectra of supernovae have already been classified. The automatic method proposing in this paper models the human way of classification using Neural Networks Multilayer Perceptron to analyze the supernovae spectra. The experiments performed obtained significant results indicating the viability of using this method in places that require an automatic analysis or that have no specialist.

Keywords: celestial mechanics and astronomy dynamics; modeling; numerical simulation and optimization; nonlinear systems and neural dynamics; supernovae automatic classification; supernovae spectrum analysis.

SCATTERING THEORY OF WALKING DROPLETS IN THE PRESENCE OF OBSTACLES

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Abstract: Walking droplets that are sustained on the surface of a vibrating liquid, have attracted considerable attention during the past decade due to their remarkable analogy with quantum wave-particle duality. This was initiated by the pioneering experiment by Y. Couder and E. Fort [1], which reported the observation of a diffraction pattern in the angular resolved profile of droplets that propagated across a single slit obstacle geometry. While the occurrence of this wave-like phenomenon can be qualitatively traced back to the coupling of the droplet with its associated surface wave, a quantitative framework for the description of the surface-wave-propelled motion of the droplet in the presence of confining boundaries and obstacles still represents a major challenge. This problem is all the more stimulating as several experiments have already reported clear effects of the geometry on the dynamics of walking droplets [2, 3].

Here we present a simple model inspired from quantum mechanics for the dynamics of a walking droplet in an arbitrary geometry [4]. We propose to describe its trajectory using a Green function approach. The Green function is related to the Helmholtz equation with Neumann boundary conditions on the obstacle(s) and outgoing conditions at infinity. For a single slit geometry our model is exactly solvable and reproduces some of the features observed experimentally. It stands for a promising candidate to account for the presence of boundaries in the walker's dynamics.

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keywords: Fluidodynamics, Plasma and Turbulence; Nonlinear Dynamics in Thermal and Fluid; Nonlinear Dynamics and Complex systems.

FIREFLY PLANETARY RING

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Abstract: Cassini spacecraft found a new and unique ring to share a trajectory with Janus and Epimetheus, co-orbital satellites of Saturn. In this study, we reveal that the ring behaves like a 'firefly'. It can only be seen from time to time, when Cassini, the ring and the Sun are ar- ranged in a particular geometric configuration. Otherwise, it remains 'in the dark', not visible to Cassini's camera. We also found a very short lifetime for the ring particles, less than a couple of decades. Con- sequently, the ring needs to be constantly replenished. Using Janus and Epimetheus as targets and considering the flux of micrometeorites that reach the ring region, we developed a detailed physical model that shows good agreement with ring data extracted from Cassini images. We demonstrate that the existence of the ring can be explained by the constant supply of material extracted from the co-orbital moons through collisions with micrometeorites and that the generated size distribution of the particles determines the light scattering regime responsible for the 'firefly' behavior of this ring.

keywords: Celestial Mechanics and Dynamical Astronomy, Modeling, Numerical Simulation and Optimization, Nonlinear Dynamics and Complex Systems.

VARIATIONAL ITERATION METHOD IN THE TIME FRACTIONAL BURGERS EQUATION

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Abstract: The variational iteration method is a analysis tool efficient for approximate non-linear fractional differential equations. Recently differents investigators are used this method in your works and we study the Lagrange multipliers of the variational iteration method for the time fractional Burgers equation and apply those in differents particular cases. In this conference we present approximations of the solutions for a particular case of the time fractional Burgers equation, with the use of the variational iteration method, the Caputo derivate for $0 < \alpha \leq 1$, after make an comparation with the Adomian descomposition method.

keywords: Nonlinear Fractional Dynamics and Applications, Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Nonlinear Dynamics in Thermal and Fluid Sciences, variational iteration method, Fractional Burgers equation and Caputo derivative.

INFLUENCE OF SAMPLE RATE AND DISCRETIZATION METHODS IN THE IDENTIFICATION OF SYSTEMS WITH HYSTERESIS

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Abstract: Hysteresis is a hard to model non-linear behavior usually found in devices involving memory effects between input and output. This paper shows how the sample rate and discretization methods affect the parameter identification of a NARX model, when applied to systems with hysteresis. A Bouc-Wen model for a magneto-rheological damper is used as a system to be identified by a NARX model, considering the above mentioned scenario and a least-square based technique is used in this work to estimate model parameters.

Keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications; Modeling, Numerical Simulation and Optimization; Nonlinear dynamics and Complex Systems; Systems with Hysteresis.

Asymptotic analysis of the everted state of circular cylindrical shell

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Abstract. The present paper is concerned with everted states of thin elastic cylindrical shell. Attention is restricted to axisymmetrical states of deformation described by Reissner's nonlinear theory of finite axisymmetrical deflections of elastic shell of revolution. For such cylindrical shells with both edges free or with one edge free and other attached to a fixed hinge, we give the conditions on small thickness parameter ε and the data ensuring that there is an everted state under zero applied load, we show how to approximate it effectively with an asymptotic series in ε whose error we can estimate, we determine the qualitative properties of the everted state, paying particular attention to the formation of the lips near the both edges, and we give specific formulas for the shape, the strain, and the stress resultants.

keywords: nonlinear dynamics and complex systems, bifurcation analysis and applications, modeling and numerical simulation, thin cylindrical shell, eversion and its asymptotic series.

A GEOGRAPHICALLY-AWARE COMPLEX NETWORK APPROACH FOR FOOT-AND-MOUTH DISEASE PHYLODYNAMICS

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Abstract:
Phylodynamics provides the theoretical foundation for the use of the information contained in genomes to draw inference on temporal and spatial behavior of organisms. In this study we use complex networks to explore the structure of genetic data within a computationally fast framework. In this work we analyze 167 1D (VP1) gene sequences from Foot-and-Mouth Disease on South-America using a family of Complex Networks embedded on geographic space. Taking genetic dissimilarity as connection threshold, our topological analysis show networks with high clustering.

keywords: Complex Networks, Epidemiology and Mathematical Models, Bioinformatics, Phylogeography, clustering.

Simulations and details of a physical prototype addressing the influence of kinematic redundancy on a parallel robot

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Abstract: Parallel Kinematic Machines are known for presenting high efficiency. Superior dynamic performance, energetic efficiency, load capacity/mass ratio, rigidity and accuracy are some of the qualities that are inducing P.K.M.'s to replace traditional Serial Robots. However, occurrence of singularities and highly anisotropic workspace are still prohibitive. Kinematic redundancy is capable of overcoming these disadvantages while leveraging the cited benefits. Clarifying this concept, this paper describes simulations of a kinematically redundant manipulator and details of a physical prototype.

Keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications; Modeling, Numerical Simulation and Optimization; Nonlinear Dynamics and Complex Systems; Parallel Robots; Kinematic Redundancy.

Ranking Scientists

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Abstract: In this age of big data and high social and professional mobility, ranking has become one of the central issues in social life and information technologies. Ranking algorithms, including the famed Google PageRank, enable automated selection of relevant information and the functioning of search engines. Ranking is an obligatory task of various selection and evaluation boards. The biased ranking of scientists can be particularly harmful, substituting misleading citation-based targets for the real aims of scientific research: strong results.

Currently the ranking of scientists is based on the h-index, which is widely perceived as an imprecise and simplistic though still useful metric. We find that the h-index actually favours modestly performing researchers and propose a simple criterion for proper ranking.

It is more difficult to manipulate the o-index than the Hirsch one but it is still possible. For many, this feature may be psychologically attractive. Focusing on a most cited paper adds extra interest to citation records. At the same time, the o-index clearly distinguishes successful researchers and provides a natural, easily implementable ranking criterion for scientists. The merit of a researcher is determined by his or her strongest results, not by the number of publications. We find that the widely used h-index-based ranking of scientists consistently contradicts this principle. This is all the more surprising given that one can so easily remove this contradiction and rank scientists reasonably and fairly.

keywords: Stochastic Models, Complex Networks, Nonlinear Dynamics and Complex Systems.

Structural Properties of Multiplex Networks

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Abstract: Many complex systems, both natural, and man-made, can be represented as multiplex or interdependent networks. Multiple dependencies make a system more fragile: damage to one element can lead to avalanches of failures throughout the system. In this talk I will present recent developments about the structural properties of multiplex networks. The transition founded is asymmetric. It is hybrid in nature, having a discontinuity like a first-order transition, but exhibiting critical behavior, only above the transition, like a second-order transition. A complete understanding of the transition cannot therefore be had without first understanding this critical behavior. I will discuss and describe the nature of such hybrid phase transitions. I will also present a theory that enables us to find the giant mutually connected component in a two-layer multiplex network with arbitrary correlations between connections of different types. I will show that the correlations between the overlapping and non-over lapping links markedly change the phase diagram of the system, leading to multiple hybrid phase transitions. For assortative correlations we observe recurrent hybrid phase transitions.

keywords: Complex Networks, Control in Complex Systems

Invariant solutions of (2+1) dimensional modified dispersive water wave system

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Abstract: The (2+1) dimensional modified dispersive water wave system is analyzed for Lie symmetries. The Lie group formalism is applied to derive symmetries of this system and the ordinary differential equations deduced are further studied and some exact solutions are obtained.

Keywords: modified dispersive water wave system; Lie symmetries; exact solutions.

Devil's Staircase in an Optomechanical Cavity

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Abstract: We study self-excited oscillation (SEO) in an on-fiber optomechanical cavity [1]. While the phase of SEO randomly diffuses in time when the laser power that is injected into the cavity is kept constant, phase locking may occur when the laser power is periodically modulated in time. We investigate the dependence of phase locking on the amplitude and frequency of the laser power modulation. We find that phase locking can be induced with a relatively low modulation amplitude provided that the ratio between the modulation frequency and the frequency of SEO is tuned close to a rational number of relatively low hierarchy in the Farey tree. To account for the experimental results a one dimensional map, which allows evaluating the time evolution of the phase of SEO, is theoretically derived. By calculating the winding number of the one dimensional map the regions of phase locking can be mapped in the plane of modulation amplitude and modulation frequency. Comparison between the theoretical predictions and the experimental findings yields a partial agreement.

[1] Hui Wang, Yuvaraj Dhayalan and Eyal Buks, arXiv:1601.07990 (2016), Phys. Rev. E **93**, 023007 (2016).

keywords: Bifurcation Analysis and Applications, Nonlinear Dynamics and Complex Systems, Synchronization in Nonlinear Systems.

INVESTIGATING THE HELICOPTER DYNAMICS BY BRED VECTOR

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Abstract: Helicopter rotor dynamics can be simulated by non-linear coupled equations of motion. The representative frequency associated to this dynamics can address different situations: unstable, periodic, and even chaotic behavior. We investigate the system responses performing several simulations under a set of frequency numerical values. However, one important issue is to evaluate the goodness of the predicted dynamics. The bred vector approach is applied to evaluate the predictability. The latter formulation deals with a comparison between reference and perturbed simulations for the dynamical system.

keywords: Non-linear motion dynamics, helicopter, bred vector.

The influence of hubs in the structure of a neuronal network during an epileptic seizure

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Abstract: In this work, we propose changes in the structure of a neuronal network with the intention to provoke strong synchronization to simulate episodes of epileptic seizure. Starting with a network of Izhikevich neurons we slowly increase the number of connections in selected nodes in a controlled way, to produce (or not) hubs. We study how these structures alter the synchronization on the spike firings interval, on individual neurons as well as on mean values, as a function of the concentration of connections for random and non-random (hubs) distribution. We also analyze how the post-ictal signal varies for the different distributions. We conclude that a network with hubs is more appropriate to represent an epileptic state.

keywords: Nonlinear Systems and Neural Dynamics, Complex Networks, Synchronization in Nonlinear Systems

Dynamics and indirect finite-time stability of modified relay-coupled chaotic systems

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In this work, we design a modified relay-coupled oscillators scheme to build a small system of three chaotic oscillators. We investigate the indirect finite-time synchronization between the coupled systems. To reach our goal, we show that, one can develop a fourth system through a particular relation such that the finite-time stability could be demonstrated. Basing ourselves on this relation we show that the systems indirectly connected could synchronize or anti-synchronize. In our case, the intermediate system could present the same global behavior even if its amplitude is subject to amplification or reduction. Other behaviors such as oscillations death of the derived system, can be observed.

keywords: Nonlinear Dynamics, Finite-time synchronization, Bifurcation, Relay-coupled oscillators, Complex systems

EFFECT OF THE TURBULENT DIFFUSION ON PASSIVE SCALAR TRANSPORT INDUCED BY AN ISOLATED VORTEX MODEL

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Abstract: On the basis of the ellipsoidal vortex model and a Monte-Carlo-type diffusion simulation, we examine the flux and ensuing distribution of passive fluid particles through the boundary of an idealized geophysical vortex. We analyze the ellipsoid vortex model in two cases: (i) the steady state when the ellipsoid is motionless, and consequently the exterior fluid is not being stirred; (ii) the perturbed case when the ellipsoid rotates periodically, which results in the appearance of stirred fluid outside the ellipsoid. Influenced by diffusion, a fluid particle is now permitted to move across the vortex boundary, thus there is an possibility that the particle will eventually be located in the exterior stirred region rather than in the ellipsoid vortex with the regular dynamics. Numerical calculations show that the diffusion significantly affects scalar spreading in the horizontal plane in the perturbed case, while in the steady state the diffusion only induces dispersion linear growth according to a Gaussian distribution.

keywords: Geophysical Nonlinear Dynamics, Turbulence, chaos, diffusion, chaotic advection.

Anomalous sea surface structures (rogue waves) as an object of statistical topography

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Abstract: We study the stochastic boundary problem of emergence of anomalous high structures on the sea surface. The kinematic boundary condition on the sea surface is assumed to be a closed stochastic quasi-linear equation. Applying the Liouville equation with random velocity field within the diffusion approximation, we derive an equation for a spatially single-point, simultaneous joint probability density of the surface elevation field and its gradient. According to the calculations of the statistical topography characteristics, we show that clustering in the absolute surface elevation gradient field happens with the unit probability. It results in the emergence of rare events such as anomalous high structures and deep gaps on the sea surface almost in every realization of a stochastic velocity field. It was shown that such structures exist only for a finite time and have restricted amplitude.

keywords: Fluid dynamics, Turbulence, Nonlinear Dynamics, statistical topography, clasterization.

Complexity Reduction for An Optimal Stopping Problem: A Two-Time-Scale Approach

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Many stochastic systems arising in applications are large, complex, and subject to uncertainty. Exact optimal control policies for these systems are difficult to obtain. In this paper, we study an optimal stopping problem driven by a Markov chain and consider the case that the chain has a large state space. Then, it is natural to divide the states into several groups so that the chain jumps frequently within each group and occasionally among these groups. We develop a two-time scale approach to reduce the overall dimensionality and construct near-optimal strategies for the original problem. Two examples will be provided to demonstrate the results.

Key words: Stochastic models, reduction of dimensionality, optimal stopping.

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Analysis of Plasma Turbulence in Texas Helimak

D. L. Toufen[1], F. A. Pereira[2], Z. O. Guimarães-Filho[2], I. L. Caldas[2], Physics of Plasmas *19*, 012307 (2012).
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We analyze alterations on the electrostatic turbulence in experiments with imposed bias to control the plasma radial electric field in Texas Helimak[1], a toroidal plasma device with a one-dimensional equilibrium, magnetic curvature and shear. We present the main characteristics of fluctuations observed in a roughly uniform gradient region [2, 3]. When the bias is positive, the turbulence shows enhanced and broadband spectra with non Gaussian PDFs having noticeable long tails (extreme events). On the other hand, negative bias reduces the turbulence level and decreases the spectrum widths. Moreover, for a negative bias, the transport is high where the waves propagate with phase velocities near the plasma flow velocity, an indication that the transport is strongly affected by a wave particle resonant interaction. On the other hand, for positive bias values, we find evidences of transport barrier.

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3- D. Toufen et al., Physics of Plasmas, *19*, 012307 (2013).

Fractional Diffusion Equation with Radial Symmetry and Reactive Boundary Conditions

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Abstract: We investigate the solutions for a system governed by fractional diffusion equations with radial symmetry and subjected to integro-differential boundary conditions. We consider the processes defined in terms of kinetic equations that couple the surface processes with the bulk dynamic enable us to describe scenarios where the surface modifies the bulk dynamics and this may change the behavior on surface.

keywords: Nonlinear Fractional Dynamics and Applications; Epidemiology and Mathematical Models; Modeling, Numerical Simulation and Optimization.

DETERMINATION OF ASTEROID SHAPES FROM LIGHTCURVES

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Abstract: Asteroids are remaining bodies of the Solar System formation process and they keep valuable information of this formation process. An excellent tool to study these objects are their lightcurves, which are obtained by monitoring the variation of the object brightness as a function of time. Applying an inversion method upon the lightcurves it is possible to calculate the spin rate of the asteroid and to derive a polyhedral representation for shape of the body. The aim of this project is to apply a numerical implementation the inversion technique in order to create a database of asteroid shapes.

keywords: Bifurcation Analysis and Applications; Celestial Mechanics and Dynamical Astronomy; Modeling, Numerical Simulation and Optimization

Analysis of shear instability inside a flow driven by a cylindrical cavity

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(Underline the name of the author whom will present the paper)

Abstract: Our study about precessing flow within a cylindrical vessel is motivated by the dynamo effect context, since it has been proposed that precession could be a good candidate for driving dynamo action in a conducting fluid. In this context, the next generation dynamo experiment currently under development at Helmholtz-Zentrum Dresden-Rossendorf (HZDR) consists of a precessing cylindrical container filled with liquid sodium. In our specific experiment (the ATER experiment) where the rotation and precession axes are at right angles, we have observed different regimes according to the value of the forcing parameter: ε, the Poincaré number (ratio of the precession to the rotation frequencies). In particular we have detected a regime flow dominated by a strong differential rotation and the presence of four cyclonic vortices sustained by precession forcing. These cyclones have been observed in our experiment involving water in a both rotating and precessing cylinder. The following mechanism can explain their generation: first the mode coupling of two inertial waves with azimuthal wavenumber m=0 and m=1 (mode forced by the precession) in the inviscid regime (at high Re numbers) creates a differential rotation regime which has been observed in the same experiment at small enough ε. Secondly, the radial profile of the corresponding axial mean flow vorticity shows an inflexion point leading to a localized inflectional/shear secondary instability. In the present paper we propose a possible mechanism studying for the formation of these cyclones by a shear inviscid instability. We use a standard criterion for instability but within our specific differential rotation profile. According to the value of the axial wavenumber (noted as k): for large k the centrifugal instability is leading whereas the inflectional/shear instability dominates for small k. Also another process will be considered in the lateral shear layers in the presence of the observed radial jets which are directed towards the center. We show that when the parameter ε is increased from low values the mode m=0 becomes the most instable one in this induced differential rotation at a reproducible threshold, which can induce further the observed cyclones. Radial jets coming from the lateral boundary layers have been also observed which can drive additional cyclones by another instability in the boundary shear layer in presence of radial flow. This new instability due to the radial inflow could significantly modify the growth rate of the former shear instability for non axisymmetric mode

keywords: Rotating fluid dynamics, nonlinear fluid dynamics, instability analysis.

(**At least the first three keywords must be chosen among the following ones:**

- Analysis and Control of Nonlinear Dynamical Systems with Practical Applications
- Bifurcation Analysis and Applications
- Epidemiology and Mathematical Models
- Fluid dynamics, Plasma and Turbulence
- Geophysical Nonlinear Dynamics
- Nonlinear Dynamics in Thermal and Fluid Sciences
- Nonlinear Dynamics of Systems with Infinite Dimension
- Nonlinear Fractional Dynamics and Applications

ANALYSING FRACTAL BASIN BOUNDARIES IN THE COPENHAGEN PROBLEM

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Abstract: The purpose of this contribution is to investigate escape basins, fractal basin boundaries and non attracting chaotic invariant sets in the planar circular restricted three-body problem for the Copenhagen case. In this problem it is important to emphasize that the two bodies P1 and P2, named primaries, have equal masses. The mass parameter of mathematical model is 0.5 and the necks around L2 and L3 open together with the same value of Jacobi constant. We are considering the scattering region situated between Lagrangian point L2 and L3. This analysis has been performed when the necks around of the collinear Lagrangian points L1, L2 and L3 are open. Different values of Jacobi constant and different values of scaled mean radius of the primaries will be used in this paper. The fractality of the basin boundaries presents a strong dependence on these two parameters. We will explore two distinct cases: when the primaries are considered as punctual masses and as finite bodies. In the second situation, we analyzed five behaviors of trajectories: trajectories which escape through the open neck around L2 or through the open neck around L3, trajectories which collide with the primaries P1 or with P2, and trajectories which do not collide or exit the scattering region after the completion of the maximum integration time. In the first case, there are only three behaviors of trajectories, as the sets of collisional trajectories are absent. The spatial distribution of escape time values is also investigated and associated with the fractality of the boundaries and the stable manifold of the chaotic saddle. This analysis and results are valuable both in the context of investigation of natural system and for design of trajectories of modern space missions..

keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Celestial Mechanics and Dynamical Astronomy, Nonlinear Dynamics and Complex Systems

Synchronization detection and characterization through mixed state embedding and recurrence quantification analysis

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Abstract: We address the detection and characterization of synchronization in networks of coupled nonlinear oscillators by comparing properties of the mixed state space (M-SS) with those of the single state spaces of each subsystem (S-SS). Such properties, as the complexity estimated by the Shannon entropy, are quantified by recurrence quantification analysis (RQA) and by using a Poincaré section to separate the temporal and amplitude signatures of the signals. We investigate the discrimination of (i) phase synchronization and (ii) full synchronization, by comparing the temporal and magnitude signatures unfolded in both the M-SS and the S-SS.

keywords: Synchronization in Nonlinear Systems, Time Series Analysis, Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Recurrence Quantification Analysis, Shannon Entropy.

Implementing the swarm algorithm in multi robots

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Abstract:
Control of Cooperative multi-robots inspection and exploration is an approaching appealing area of research in the field of robotics. Collaborative behavior algorithms utilizing swarm intelligence are being developed in many practical applications. Inspection of aircraft and power generation machinery using a swarm of miniature robots is a promising application both from an intellectual and a commercial perspective. In this digital age, the demand for technological solutions to increasingly complex problems is climbing rapidly. With this increase in demand, the tasks which robots are required to execute also rapidly grow in variety and difficulty. A single robot is no longer the best solution for many of these new application domains; instead, teams of robots are required to coordinate intelligently for successful task execution. For example, a single robot is not an efficient solution to automated construction, urban search and rescue, assembly-line automation, mapping/investigation of unknown/hazardous environments, and many other similar tasks.

This paper utilizes different algorithms for inspection planning based on decomposition and distribution of the tasks among multiple units. Experiments are planned in which several relatively simple autonomous platforms will work together in a coordinated fashion to carry out complex maintenance-type tasks within the constrained working environment modeled on the interior of a turbofan engine.

Validating the algorithms and providing justification for further specialization of the hardware toward the true application will be proof of this concept.

In multi-robot systems, the opportunity for simultaneous sensing and action in multiple locations offers potential advantages over single robot systems in robustness, efficiency, and application feasibility. In a multi-robot system, unit redundancy may allow a team of robots to complete a task despite one or more robot failures, while simultaneous action may allow the team to finish the task more quickly or efficiently than a single robot.

The multi-robot systems explored in this study range from fully distributed, swarm inspired systems to centrally supervised, deliberative systems, adding a diverse set of such building blocks to the field's ever-increasing collective understanding of multi-robot system design. At the distributed and reactive end of the multi-robot system spectrum, an important part of this study is the mathematical modeling methodologies developed to predict and optimize a robotic swarm's performance for several tasks.

In multi-robot systems, the opportunity for simultaneous sensing and action in multiple locations offers potential advantages over single robot systems in robustness, efficiency, and application feasibility. In a multi-robot system, unit redundancy may allow a team of robots to complete a task despite one or more robot failures, while simultaneous action may allow the team to finish the task more quickly or efficiently than a single robot. In the long term, especially for applications in which robots are subject to heavy use, damage, and replacement, multi-robot systems may also offer a cost advantage due to the potential for mass production.The multi-robot systems explored in this study range from fully distributed, swarm inspired systems to centrally supervised, deliberative systems, adding a diverse set of such building blocks to the field's ever-increasing collective understanding of multi-robot system design.

Key words: Multi Robots, Swarm Intelligent, Inspection, mobile Robots

PARAMETRIC DYNAMICS OF AN EULER-BERNOULLI BEAM

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Abstract: We investigate the dynamics of vibration of a non-uniform beam with a cross-section that varies linearly in the direction of its length. The vibration amplitude (W) is modeled by product of a spatial function (v(x)) and a temporal (u(t)), i.e. W=v(x)u(t). Time's dynamics can be identified as a parametric oscillation dynamics. First we investigate the non damping case ant it takes the form of Mathieu's equation. In the second case, it is considered that the periodic exciting force is zero, becoming therefore a simple vibration equation. Also, the problem was solved numerically using Runge Kutta and Differential Transform Method to obtain solutions. We compare the efficiency of those methods.

keywords: Chaos and Global Nonlinear Dynamics, Modeling, Numerical Simulation and Optimization, Nonlinear Dynamics of Systems with Infinite Dimension, Parametric Oscillations, Mathieu's equation.

NONLINEAR PARTICLE FILTER APPLIED TO ORBIT DETERMINATION OF ARTIFICIAL SATELLITES

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Abstract: The purpose is to discuss a particle filter, specifically a Bayesian bootstrap filter algorithm, applied to the estimation of the state vector that characterizes the orbit of a satellite, using a set of GPS measurements. The orbit determination is a nonlinear problem, with respect to the dynamics and the measurements equations, in which the disturbing forces and the measurements are not easily modeled. This process consists essentially of estimating values that completely specify the body trajectory in the space, processing a set of measurements (observations) related to this body. Such observations can be collected through a tracking network grounded on Earth or through sensors, like GPS receivers on-board the satellite. Throughout an on-board GPS receiver it is possible to obtain nonlinear measurements (pseudo-ranges) that can be processed to estimate the orbital state. The bootstrap particle filter is proposed for implementing recursive Bayesian filters. It is a statistical, brute-force approach to estimation that often works well for systems that are highly nonlinear, as the orbital dynamics. Here, the bootstrap particle filter will be implemented with resampling and schemes (roughening and prior editing) for combating sample impoverishment, that is, the reduction in the number of truly distinct sample values. The standard differential equations describing the orbital motion and the GPS measurements equations are adapted for the nonlinear particle filter, so that the bootstrap algorithm is also used for estimating the orbital state. The development to be presented will be evaluated through performance, convergence speed and computational implementation complexity and cost, comparing the bootstrap algorithm results obtained results against the unscented Kalman filter solution for the same problem. Based on the analysis of such criteria, the advantages and drawbacks of the implementations will be presented.

keywords: Celestial Mechanics and Dynamical Astronomy, Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Stochastic Models, Orbit Determination, Particle Filter.

CROSS-SAMPLE ENTROPY ANALYSIS FOR OCEANIC NIÑO INDEX DATA

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Abstract: The study was conducted with data from the meteorological station of Cuiabá, provided by INMET (National Institute of Meteorology) through of BDMEP (Meteorological Data Bank for Education and Research) in the 1961-2015 period. The evidence of a possible connection between air temperature dynamic states and the Oceanic Niño Index - ONI, were verified by Cross-Sample Entropy analysis of the data. The results point to the existence of a climate system with low dimensionality dynamic regulation and presence of deterministic chaos. The temporal evolution of the nonlinear parameters obtained presents a complex dynamic that can be related to ONI index fluctuations.

keywords: Time Series Analysis, Climate Dynamics, Synchronization in Nonlinear Systems.

SIMULATION OF CHUA'S CIRCUIT BY MEANS OF INTERVAL ANALYSIS

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Abstract: The Chua's circuit has been considered as one of the most important paradigms for nonlinear science studies. Its simulations is usually undertaken by means of numerical methods under the rules of IEEE 754-2008 floating-point arithmetic standard. Although, it is well known the propagation error issue, little attention has been given to the relation between this error and the inequalities presented in the Chua's circuit model. Using interval analysis we showed that the error may shift the bifurcation point, where the circuit alternate his behaviour form double scroll to scroll attractor.

Keywords: Bifurcation Analysis and Applications, Modeling, Chua's Circuit, Numeric Ranges, Numerical Simulation and Optimization, Analysis and Control of Nonlinear Dynamical Systems with Practical Applications.

REVISITING HAMMEL ET AL. (1987): DOES THE SHADOWING PROPERTY HOLD FOR MODERN COMPUTERS?

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Abstract: Computational techniques are extensively applied in nonlinear science. However, while the use of computers for research has been expressive, the evaluation of numerical results does not grow in the same pace. Hammel et al. (Journal of Complexity, 1987, 3(2), 136--145) were pioneers in the numerical reliability field and have proved a theorem that a pseudo-orbit of a logistic map is shadowed by a true orbit within a distance of 10^{-8} for 10^7 iterates. We checked this theorem in a modern computational platform, and on the contrary, we found the simulation of the logistic map with less than 100 iterates presents an error greater than 10^{-8}. Our test is based on the concept of multiple pseudo-orbits and symbolic computing.

Keywords: Modeling, Numerical Simulation and Optimization; Nonlinear Dynamics and Complex Systems; Chaos and Global Nonlinear Dynamics; Pseudo-Orbits; Nonhyperbolic Maps.

Integrable classical restricted two-center MICZ-Kepler problem on surfaces of revolution

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Abstract: We define the Landau problem on the two-dimensional ellipsoid, hyperboloid and paraboloid of revolution. Starting from the two-center McIntosh-Cisneros-Zwanziger (MICZ)-Kepler system and making the reduction into these two-dimensional surfaces, we obtain the Hamiltonians of a charged particle moving on the corresponding surface of revolution in a magnetic field that conserves the symmetry of the two-dimensional surface (Landau problem). In each case we figure out the values of the parameters for which the qualitative character of the motion coincides with that of a free particle moving on the same two-dimensional surface. When the trajectories are finite, we also construct the action-angle variables for the problems.

keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Celestial Mechanics and Dynamical Astronomy, Nonlinear Dynamics of Systems with Infinite Dimension.

Analysis of spatiotemporal patterns of reported cases of AIDS and tuberculosis in the city of São Paulo by administrative districts, using bayesian disease mapping

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Abstract: Investigate the spatiotemporal patterns of AIDS and tuberculosis (TB) incidents cases of between the years 2006 to 2012 in São Paulo city, SP, according to its 96 Administrative Districts, as well as their associations with the characteristics of income. This is an ecological study, and the tools used to incidence rates estimation and analysis of data is Bayesian regression models that incorporate spatial and temporal effects. These models include random effects with a CAR distribution (conditional autoregressive) bivariate normal that capture the influence of adjacent fields on the number of cases reported in each region, according to sex. Estimates of the model parameters were obtained by stochastic simulation method MCMC (Monte Carlo Markov Chain). The spatiotemporal pattern shows the reverse pattern of the Income association with TB, and AIDS with TB in space in relation to incident cases in men. The results are useful to support the policy planning and health actions directed to the AIDS and TB in areas and at-risk populations in São Paulo.

keywords: epidemiology and mathematical models, sthocastic models, time series analysis, spatial statistics, bayesian disease mapping.

DYNAMICAL CHARACTERIZATION OF NONLINEAR SYSTEMS THROUGH COMPLEX NETWORKS

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Abstract: The dynamical characterization of nonlinear systems is a great challenge and it is usually performed by using Lyapunov exponents and bifurcation diagrams, which is not always an easy task. In this work, we present an approach for dynamical characterization using symbolic dynamics and complex networks. As an example, we apply the proposed methodology to the Logistic Map, as it is a paradigm of dynamical systems. Some properties of the networks generated by the time series match with the expected behaviors of the system. In other words, our methodology could identify periodic windows and chaos.

keywords: Chaos and Global Nonlinear Dynamics, Complex networks, Time Series Analysis, Logistic Map.

Study of Sailboat for binaries systems

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Abstract: Abstract: The "sailboat" is a stable region in the Pluto-Charon discovered by Giuliatti Winter et al. (2010), who also showed this region is associated with a family BD of periodic orbits (Broucke, 1968) derived from the planar, circular, restricted three-body problem. The purpose our research is to extend the work of Giuliatti Winter et al. (2014) looking for the existence of the Sailboat for any binary system. We analyzed this region through numerical simulations of the test particles of S-type orbits in hypothetical systems with different values of mass ratio (μ) and for several orbital configurations. Our results show the sailboat is robust and it exists for μ=[0.05,0.27] and for large intervals of argument of pericentre and inclination.

keywords: Celestial Mechanics and Dynamical Astronomy, Modeling, Numerical Simulation and Optimization, Nonlinear Dynamics and Complex Systems.

TITLE: On Nonlinear Oscillations Modeling in Structural Engineering and Solar Corona

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Abstract: The goal of this work is to discuss the possibility of applying models for vortex-induced vibration, usually associated with structural engineering problems, in a new area. The models could be useful to model the dynamics of nonlinear oscillation in coronal loops. Models for vortex-induced vibration use two-nonlinear coupled oscillators to model the system: one oscillator describing the oscillation of the structure and other one describing the vortex dynamics in a fluid. The coupling of nonlinear oscillators like Van der Pol, Duffing and Duffing-Van der Pol could be useful in this modeling.

keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Bifurcation Analysis and Applications, Fluidodynamics, Plasma and Turbulence, Van der Pol, vortex.

Shearless bifurcation on symplectic map with a local null rotation number

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Abstract: We introduce bidimensional symplectic map to describe the Poincaré map of magnetic field lines in large aspect ratio tokamak equilibria with reversed non-monotonic plasma current density profiles. For this map, we investigate the effect of the symmetry breaking due to the toroidal correction with a peculiar invariant, namely, a magnetic surface with a null rotation number, enclosing a vanishing current. We find that this rotationless invariant surface is surrounded by many small island chains. Furthermore, near such invariant, the symmetry breaking gives rise to two magnetic shearless invariants surrounded by twin island chains. We also find chaotic lines adjacent to all the observed islands created by the considered structurally unstable equilibria.

keywords: chaos and global nonlinear dyamics, control of chaos, bifurcation analysis and applications.

Solutions for Fractional Diffusion Equations with Reaction Terms

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Abstract: We investigate the behavior of a set of fractional diffusion equations coupled by the reaction terms. We consider the presence of fractional time derivatives and spatial memory effects in the diffusive term. We analyze the solutions and, in particular, the influence of the reaction terms on the spreading of these solutions. The results obtained show a rich class of behaviors which can be connected to anomalous diffusion.

keywords: Nonlinear Fractional Dynamics and Applications; Epidemiology and Mathematical Models; Modeling, Numerical Simulation and Optimization

Axiomatic Local Metric Derivatives With Mittag-Leffler Eigenfunctions for Low-Level Fractionality

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Abstract: Here, we build up an axiomatic local metric derivative that exhibits the Mittag-Leffler as an eigenfunction and is valid for low-level fractionality. This version of deformed or metric derivative can substitute the controversial versions by Jumarie and the misnamed local fractional derivative based on the more-recent Jumarie's approach with similar rules, but with a solid axiomatic basis in the limit pointed out here. We also present some comments on the limits of validity for the nonlocal controversial formalism.

keywords: Nonlinear Fractional Dynamics and Applications, Nonlinear Dynamics and Complex Systems, Modeling, Numerical Simulation and Optimization, Local Metric Derivatives, Mittag-Leffler Eigenfunctions, Low-Level Fractionality.

MODELING SMART STRUCTURES TO RELOAD SMARTPHONES USING LINEAR QUADRATIC REGULATOR (LQR) CONTROLLER AND THE FINITE ELEMENT METHOD (FEM)

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Abstract: Smartphones are among the most electronic devices nowadays, which is great.
However, these devices are noticeably known for their short battery lives. In order to solve this problem, this project proposes to feed these batteries without a need to do it into the sockets. All that would be done through the use of smart structures. That said, we intend to model a cantiliver beam which embedded piezoeletric elements using LQR controller in the regenerative mode and the FEM.

keywords:. Modeling, Numerical Simulation and Optimization, Smart Structures.

Time series from text co-occurrence networks

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Abstract: Co-occurrence networks constructed from written texts present complex features such as power laws for many network metrics. Models show that these features can be obtained from preferential attachment growing mechanisms. Even though network metrics have been shown to characterize text authorship, the relation between network evolution and authorship has not yet been studied. In this work texts are modeled as time series of co-occurrence networks. The series have been found to be stationary up to a p-value of 0.05. These were successfully used for authorship identification.

keywords: Complex Networks, Time Series Analysis, Discrete Dynamical Systems.

Modelling the Air-Water Interface

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Abstract: The air-water interface is of huge importance to a wide range of environmental, biological and industrial chemistry. It shows complex behaviour and continues to surprise both experimental and theoretical communities. Using the Amber 12 molecular mechanics software we have implemented ways to deal with long range Lennard-Jones corrections in systems containing interfaces based on the methodology of Janecek. We present how these corrections are important for replicating surface behaviour in water, and a novel way to thermodynamically estimate surface energetic and entropic terms.

keywords:
Computational Chemistry, Water, Modeling, Numerical Simulation and Optimization, Nonlinear Dynamics and Complex Systems, System Biology

Synchronization detection and characterization through mixed state embedding and recurrence quantification analysis

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Abstract: We address the detection and characterization of synchronization in networks of coupled nonlinear oscillators by comparing properties of the mixed state space (M-SS) with those of the single state spaces of each subsystem (S-SS). Such properties, as the complexity estimated by the Shannon entropy, are quantified by recurrence quantification analysis (RQA) and by using a Poincaré section to separate the temporal and amplitude signatures of the signals. We investigate the discrimination of (i) phase synchronization and (ii) full synchronization, by comparing the temporal and magnitude signatures unfolded in both the M-SS and the S-SS.

keywords: Synchronization in Nonlinear Systems, Time Series Analysis, Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Recurrence Quantification Analysis, Shannon Entropy.

Suspension system in a spray boom using a fractional PID controller

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Abstract: This work investigates, by means of numerical simulations, a suspension system in a spray boom using a fractional PID controller. In recent years, an increase in global demand for food requires a major usage of fertilizers and pesticides. However, their applications in agriculture should be as uniform as possible, reducing waste, production losses, economic consequences and environmental contamination. In general, it has been given greater importance to the active ingredient used like poison over application of techniques and equipment. This means that there is a decrease in the control, leading to an increase of the recommended doses for application. In order to decrease the scroll of the spray boom and thus ensure more uniform application, the modern sprayers are equipped with a suspension that has the function to keep the spray boom parallel to the ground. This suspension requires a control system that optimizes its stabilization function. In this study, a fractional controller is applied on a sprayer when it is in operation. Simulated and experimental data are considered. The experimental data of acceleration caused by vibration in the spray bar are obtained with the use of sensors installed on the bar. These experiments were conducted at the Biosystems Engineering Department, FZEA- USP. The main and preliminary results show a better performance of the fractional controller when compared to a classical PID indicating that such controllers can contribute to the development of more efficient systems involving applying pesticides and fertilizers in agriculture.

keywords: Modeling, Numerical Simulation and Optimization; Nonlinear Fractional Dynamics and Applications; Control in Complex Systems.

Study of Communities in a Real Brain Network

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(Underline the name of the author whom will present the paper)

Abstract: There is a big discussion in neuroscience about whether simulations can model the properties of real brain networks. For example, considering the cortex as a union of mesoscale units (cortical areas), how can we construct a brain network from microscopic units (neurons) that can recreate structures responsible for cognitive tasks? In this work we show that this is indeed possible just following some proportions of connections between networks. Another interesting point is the possibility to work with very small networks that together reconstruct the community organization as the huge real neural networks.

- **keywords**: Complex Networks, Modeling, Numerical Simulation and Optimization, Nonlinear Systems and Neural Dynamics.

ANALYSIS OF COUPLED DRILL-STRING VIBRATIONS USING A NONSMOOTH SYSTEM

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Abstract: During oil drilling operations the drill-string can be subjected to severe vibrations, which leads to an onerous and inefficient process. Therewith a great effort has been done on the drill-string dynamical analysis. In this regard, many models have been proposed in order to investigate all related phenomena of drill-string vibrations. The most important issue related to drill-string dynamics is nonsmooth nonlinearities imposed by bit-rock interactions and contact between the drill-string and the wellbore.

In essence, drill-string dynamics may be analyzed by considering different vibration modes: axial, torsional and lateral. The coupled analysis of these modes gives a proper comprehension of the drill-string dynamics, elucidating several critical vibration responses. In this regard, it is important to highlight bit-bounce, associated with drill-string contact lost; stick-slip, related to drill-string rotating stops; whirl, characterized by a rotational response of a deflected drill-string around the well center. In general, lumpedmodels present a proper description of the system dynamics.

This paper considers a drill-string dynamical analysis considering an axial-torsion-lateral coupled model. A four-degrees of freedom nonsmoothmodel is adopted considering the coupling between modes, bit-rock and wellbore interaction,eccentricity and hydrodynamic forces due to fluid resistance to lateral bending.

A parametric study is done through phase spacesand bifurcation diagrams. The goal is to understand how thevibration modes interact with each other and to assess under what operational conditions the drill-string exhibits critical vibrations. The mitigation of these critical responses is also of concern. A varietyof operational conditionsare investigated, allowing one to obtain a deep understanding of the drill-string global behavior.

Critical vibration responses are of special interest. Bit-bounce, stick-slip and whirl are shown, discussing how they are triggered, mitigated and affectedby other modes.Numerical results are qualitatively compared with experimental field observations confirming the main conclusions.

- **Keywords:** Discontinuous Dynamical Systems, Nonlinear Dynamics and Complex Systems, Chaos and Global Nonlinear Dynamics, Drilling, Nonsmooth Systems.

Dynamic optimization model to control weed infestation by herbicide rotation

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Abstract: We propose a dynamic optimization model for weed infestation control using selective herbicide application in a corn crop system. The weed population model is based on the life cycle of weeds present in a single agricultural field. This model incorporates the weed resistance to herbicides that occurs on account of an evolutionary process. Additionally, we propose a weed control strategy based on herbicide rotation aimed at reducing the use of herbicides, maximizing economic returns and minimizing the environmental impacts caused by excessive use of herbicide, using a mixed integer nonlinear programming problem solved by the branch and bound method.

Keywords: Modeling, Numerical Simulation, Optimization, Nonlinear dynamics, Weed control.

BRED VECTOR APPLIED TO THE ATMOSPHERIC DYNAMICS

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Abstract: One remarkable conquer of science was the numerical weather prediction. However, some dynamics processes are not well represented in the simulation, generating a degradation of the forecasting. In addition, a chaotic atmospheric dynamics is also noted, with strong dependency of the initial condition. The initial condition is never known in a completed way. Indeed, the procedure to determine the initial condition in the operational prediction center is called *data assimilation*, where the background fields (forecasted atmospheric state) is combined with observations for producing the *analysis* – the new initial condition. The bred vector approach can be employed to investigate the sensitivity of a certain process in the atmospheric dynamics simulation, detecting the fastest-growing instabilities. The latter scheme is also applied to evaluate the goodness of the predicted dynamics, i.e., the breeding process is applied to evaluate the predictability. The bred vector is computed as a difference between reference and perturbed simulations for the dynamical system after a time period of integration. After that time integration period, the bred vector is scaled at the same size as the initial perturbation, and a new perturbed initial condition is added to restart the process.

keywords: Atmospheric dynamics, global circulation model, bred vector.

THE NON-AXISYMMETRIC MAGNETIC SEPARATRIX IN FUSION PLASMAS

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Abstract: The magneto-hydrodynamic (MHD) equilibrium of fusion plasmas is nominally axisymmetric, presenting nested toroidal magnetic surfaces enclosed by a homoclinic separatrix. In more general situations the axial symmetry is broken by internal MHD instabilities or by the external application of 3D fields used to mitigate instabilities. In such cases, the magnetic separatrix can be redefined in terms of the perturbed magnetic saddle, leading to homoclinic lobes. In this work we present a numerical method to calculate high-resolution invariant manifolds in the Poincar\'e section, leading to the magnetic surface delimiting the confined field-lines for realistic tokamak discharges.

keywords: Fluidodynamics, Plasma and Turbulence, Modeling, Numerical Simulation and Optimization, Nonlinear Dynamics in Thermal and Fluid Sciences, Analysis and Control of Nonlinear Dynamical Systems with Practical Applications.

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Carrying capacity and accumulation of hubs in networks

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Abstract: The effect of finiteness in degree number is analysed on a growing network. The dynamics is governed by a rule where the degree number increases under a scheme similar to the Malthus-Verhulst model in the context of population growth. One notices that the second moment of degree is closely related to the linking probability of this growing network. The degree distribution is analysed in both stationary and time-dependent regimes through some exact results and simulations, and a scaling behaviour is found in asymptotically large time. For finite times, the time-dependent degree distribution displays an accumulation of hubs as a result of competition between attractive and repulsive terms in linking probability.

keywords:

- Nonlinear Dynamics and Complex Systems
- Complex Networks
- System Biology

CHAOS AND HYPERCHAOS IN A REDUCED MODEL OF HYDROMAGNETIC CONVECTION

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Abstract: In this work, a numerical study of a reduced model of hydromagnetic convection is presented. By considering a background magnetic field in a conducting fluid in a plane layer, a generalized Lorenz model is used to investigate transitions to chaos and hyperchaos as a function of two control parameters, the reduced Rayleigh number and the magnitude of the background magnetic field. The spectrum of Lyapunov exponents is used to describe the system states and dynamical phenomena such as multistability, merging crises and hyperchaotic saddles are reported.

keywords: Nonlinear dynamics and complex systems, generalized Lorenz model, chaos and global nonlinear dynamics.

Title: **Kinetic instabilities in the electrochemical reform**

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Abstract:

Electrochemical reforming of alcohols refers to the production of hydrogen and chemicals as a consequence of the electrolytic oxidation of the alcohol fuel. In this work we present results related to the kinetic instabilities (oscillations) that occur in the electrochemical reforming of ethanol using a Proton Exchange Membrane Electrolysis Cell (PEMEC) and Pt/C as catalyst. We show the characterization of different types of voltage oscillations, its relationship with the generation of hydrogen and byproducts and the effect of the oscillatory behavior of the voltage on the overall performance of the system.

keywords: Nonlinear Dynamics, Control, Practical Applications.

Testing the REBOUND in the Nice Model

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Abstract:

In 2005, was published the results of theory what today we call Nice model. It describes the dynamic evolution of Solar System after the formation of giant planets. This model is of interest because shows how, from the initial stage of Solar System constituted of an planetesimal disk and the newly formed planets Jupiter, Saturn, Uranus and Neptune, may have evolved to the current orbital configuration of our Solar System. Thus, using this model can explain all the important current characteristics of these planets, such as its values of semi-major axis, eccentricity and their mutual inclinations. The REBOUND is an integration package, open source, for simulation of N-body developed by Rein and Liu in 2011, and it have symplectic integrators, such as the map of Wisdom-Holman in updated versions in 2015. Rebound also has integrators based on Gauss-Radau quadratures for the treatment conservative and nonconservative forces, which can be used for simulations about close encounters and highly eccentric orbits. In this work, we adapt REBOUND for the simulation of the dynamics of long-term planetary systems, with the conditions generated by the Nice model and study the gravitational effects of the giant planets of the solar system interacting with the planetesimal disk.

keywords: Celestial Mechanics and Dynamical Astronomy, Chaos and Global Nonlinear Dynamics, Modeling, Numerical Simulation and Optimization.

Irregular dynamics of the center of mass of droplets

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Abstract: The understanding of droplets is important to different problems and applications, like the wetting and the diagnosis of airways condition in the lung. In this work, we performed both molecular dynamics (MD) and Monte Carlo (MC) simulation to solve the displacement of center of mass (CM) of droplets, in order to calculate the Hurst exponent in z-coordenate and in the xy-plane. Depending on the confinement condition, the CM motion, can be persistent, antipersistent, Brownian or confined. Also from this studies, we could correlate the MC step with the time in the MD simulation.

keywords: Time Series Analysis; Modeling, Numerical Simulation and Optimization; Fluidodynamics, Plasma and Turbulence; Droplet; Liquid Bridge

Assessment the change on rhythm cardiac produces by the metabolic syndrome in rats: using nonlinear methods

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Abstract

In the mammals of heart rate depend on the production and conduction action potential cardiac with origin in pacemaker and any electrical changes could be produced sudden arrhythmias in the heart. The current evidence suggests that the rats with metabolic syndrome presented changes in the sino atrial node. However, is not relates the alteration produces by metabolic syndrome and rhythm cardiac such as the changes only related to vascular injury. In this study shows the existence of this relationship. We induced metabolic syndrome in young Wistar rats administering 20% sucrose in the drinking water. Ten and twenty eight weeks later, the rats were anesthetized and the electrocardiogram recorded, disclosed the heart rate decline from 237 bpm in control at 198 bpm in metabolic syndrome. Using conventional microelectrodes technics observed that the production, morphology and propagated of action potential in sino atrial node was inadequate. The time series and Poincare plots of RR and action potential intervals showed a decreased ability to regulate hear rate. In additionally, this data was correlated with increase the collagen and lipid area in pacemaker produced unexcitable segments rise the probably of arrhythmias by alterations like to ageing.

Keywords: Nonlinear Dynamics and Complex Systems, System Biology, Time Series Analysis

Introduction

MASCONS TO FIND EQUILIBRIUM POINTS AROUND SMALL BODIES OF IRREGULAR SHAPE

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Abstract: Small bodies like asteroids and comets have garnered ever increasing attention over the past few years due the information they have on Solar System formation and evolution, and the potential hazard they pose on our planet. Missions that intend study the asteroids need a precise description of the body's gravitational potential for approach and landing. To model the gravitational potential of irregular bodies there is the spherical harmonics model, but this model is useful just at large distances. Another way to model the gravitational potential is by the constant density polyhedron model. In this work we adopt another gravitational potential model that is called mass concentration (mascons) model. It consists into model the irregular body with mass distributed in points that are located inside the irregular body. With this model we look after equilibrium points. With these points we can simulate orbits around an irregular body looking for trajectories for landing.

keywords: Celestial Mechanics , Mascons, Equilibrium Points, Small Bodies, Gravitational Potential.

ASSOCIATIVE WAVELETS AND COMPLEX NETWORKS DETECTION OF PERIODIC WINDOWS IN THE LOGISTIC MAP: PRELIMINARY STUDIES.

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Abstract: In this work, we investigate a new method for the detection of periodic windows in the logistic map. The detection should be done from the quantification metrics in complex networks, whose topology is determined by the result of a wavelet analysis of the series generated for different parameters of the logistic map. Wavelet transforms are under study to characterize the periodicity of those windows; particularly tunable Q-factor wavelet transform has shown promising results. The idea is to extend these techniques to chaotic windows in the near future.

keywords: Chaos and Global Nonlinear Dynamics, Complex Networks, Time Series Analysis, Logistic Map, Wavelet Transform.

Hydrodynamics formation of the Gamma Cephei b

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Abstract: The discovery of the exoplanets showed that many systems have giant planets very close of the stars which orbit. These configurations were a surprise to the scientific community, as the Solar System has giant planets at large distances from the Sun. Jupiter, the gaseous planet closest to the Sun, it is at a distance of 5.20 AU. The Gamma Cephei binary system has your two stars very close, approximately 20 UA of distance. Besides the two stars, the system has a planet at 2.05 UA with a mass nearby of 1.85 Jupiter masses. In this work, we analyzed the characteristics required in the initial stage of a disk of gas for the formation of Gamma Cephei b. The simulations are performed with FARGO 2D (MASSET, 2000). The results and analyzes are in progress and will be presented during the meeting.

Keywords: Dynamical Astronomy, Modeling, Numerical Simulation and Optimization, Fluidodynamics, Plasma and Turbulence, Gamma Cephei System, Hydrodynamics formation.

Extension of the Invariance Principle for Switched Delay Systems

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(Underline the name of the author whom will present the paper)

Abstract: This work presents an extension of invariance principle for a class of switched delay systems. This extension is useful to obtain estimates of the attractor and basin of attraction for the solutions, which are obtained by using a common auxiliary function or multiple auxiliary functions which play the same hole as Lyapunov function. The main feature of these new results are that the derivative of the auxiliary functions can be assume positive values in some sets and are used to analyze the asymptotic behavior of the switching solution.

keywords: Nonlinear systems, systems of infinite dimension, analysis, switched system, attractors.

Analysis of the gravitational potential and the equilibrium points of the asteroid 2063 Bacchus.

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Abstract: We locate the equilibrium points in the gravitational field of the asteroid 2063 Bacchus, four external to the body and an internal. We investigated what happens to those points where a parameter changes, such as rotation speed and the density of the asteroid. As the rotational speed increases the points approach the object because there is an increase in the centrifugal force and hence there must be an increase in gravitational force so that there is equilibrium of forces. As the equilibrium points are close to Bacchus, some collide and disappear until only the point of inner balance. During the time of collision occurs some kind of bifurcation point and stability is altered and the type of point (degenerate or non-degenerate). There are eight cases for equilibrium points not degenerated in the gravitational field of an asteroid, and seven cases for the degenerate points. This rating will depend on the eigenvalues for each found point. For example, a balance is linearly stable if, and only if its eigenvalues are all pure imaginary. So when is the collision of two points, there is a fork, and the eigenvalues of this new point change completely. This directly influences the point of stability. A detailed analysis of the location and stability of those points was performed. We studied seven types of bifurcations that can occur at the time of the collision points.

keywords: Bifurcation, asteroid, equilibrium points, stability, eigenvalues

Study of the dynamic of micrometric particles in the arcs of Neptune's Adams ring

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Abstract: Since their discovery in 1984, researchers believed that the stability of the arcs Egalité, Fraternité, Liberté and Courage, located in Neptune's Adams ring, is due to a corotation inclined resonance (CIR) 42:43 with Galatea. However, data from 2003 showed that the arcs are displaced of the resonance region.
Renner et al. 2014 propose that the stability of the system is caused by four co-orbital satellites, along with the effect of the proximity of the CIR resonance. Based on this hypothesis and using the package Mercury, we numerically simulated four co-orbital satellites with angular separation Φ=48.81º, Φ = 58.38º and Φ = 73.89º and semi-major axis displaced 0.25km from the CIR resonance region, taking into account the gravitational effects of Neptune and Galatea.
As a result we found that the satellites are still trapped in a 43:42 Lindblad resonance (LER) with Galatea, but they have a radial diplacement of about **?km**. By simulating a system of µm sized particles, we obtained 4 regions formed by particles trapped in Lindblad Eccentric Resonance with Galatea. Preliminary results for the effect of solar radiation pressure under these particles will also be presented. The authors acknowledge the support provided by FAPESP and CNPq.

keywords: Celestial Mechanics and Dynamical Astronomy, Modeling, Numerical Simulation and Optimization, Nonlinear Dynamics and Complex Systems.

Alternative Paths to Reach Asteroids

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Abstract: Near-Earth Asteroids (NEA) tell us a lot about the early Solar System. Space missions aimed to those objects can provide information for a better understanding of physical and chemical processes of Earth's formation. In this perspective, it is necessary to invest in optimized techniques orbital transfer able to achieve these objects with reduced spent fuel. In this paper, we explore the dynamics of unstable periodic orbits around the Lagrangian point L1 and the gravitational influence of the moon in order to get the energy needed to overcome the gravity of the Earth-Moon system and reach a NEA. The fuel consumption in this kind of maneuver is less than that required in other approaches. The escape trajectories obtained present sensitive dependence on initial conditions and can be judiciously controlled by small perturbations so that they are targeted to specific regions of the Solar System, being propitious mainly for missions whose targets belong to Apollos and Atens classes.

keywords: Celestial Mechanics and Dynamical Astronomy, Escape Trajectories, NEA.

Planetary formation in a coplanar triple stellar system

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Abstract: In this paper we present a numerical study of planetary formation in a triple stellar system starting from the last stage of formation when protoplanets are already formed. The model consists of a protoplanetary disk orbiting the center of mass of a binary and a disturbing star 61,9 AU away orbiting the system's center of mass and all bodies are in coplanar orbits. With the aim of studying the formation efficiency of the planets results of numerical integration showed that the most massive discs tend to form a smaller number of massive planets, as expected. Reconnecting with other studies on the formation of the solar system, the triple system data studied have similar characteristics to the terrestrial planets of the solar system, for example, the order of formation time and nearly circular orbits.

keywords: Celestial Mechanics and Dynamical Astronomy, Modeling, Numerical Simulation and Optimization, Nonlinear Dynamics and Complex Systems, Planetary Formation, Triple Stellar System.

THE RADIAL DISTRIBUTION OF THE DUSTY RINGS OF URANUS

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Abstract: The equinox of Uranus occurs only every 42 years, and the last passage of the Sun through the ring plane happened in late 2007. This particular configuration, also known as Ring Plane Crossing (RPX), is an excellent opportunity to investigate the dust regions of the ring system, since the illumination is parallel to the ring plane and the main narrow rings are obscured due to mutual shadowing thus revealing tenuous structures. Taking advantage of the adaptative optics system of the Very Large Telescope (VLT), almost 500 images of the Uranian system were taken in the infrared (Ks band), covering the period immediately before the 2007 RPX up to three days after it. First we present the data reduction process and the algorithms that were necessary to implement in order to combine the images to enhance faint structures. Our results show a wide dust band from 30,000 km to 52.000 km, permeating the entire region of the main rings. After removing the light scattered by the planet it was possible to identify a denser region around 42,000~km, which may be related to the ZETA ring detected by the Voyager cameras. It is also under development a photometric model, that will allow us to calculate the optical depth of the rings and to improve the astrometry of some of the small satellites of the Portia family. The knowledge of the precise radial distribution of dust will help to better understand the interaction between ring particles and satellites, as well as the role of non-gravitational forces on the orbital evolution of dust grains.

keywords: Celestial Mechanics and Dynamical Astronomy, Modeling, Numerical Simulation and Optimization, Nonlinear Dynamics and Complex Systems.

CORRELATED TIME SERIES USING MIXED MODELS IN A BAYESIAN PERSPECTIVE

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Abstract: The goal of this work is to propose the application of an autoregressive model considering two data series: hospital internment and inhalable particulate material with aerodynamic diameter less than 10 µm in a city in the state of São Paulo (oct/2003 to dez/2007). In a Bayesian perspective, using MCMC methods, we consider a mixed model with random effects to capture the possible correlation between the series and residuals with a Student-t distribution. This model is more appropriate when compared to independent models with normal residuals.

keywords: Time series correlated, Bayesian Inference, Student-t residuals, hospital internment, MCMC methods.

MANUFACTURING OPTIMIZATION USING COUPLED LOT SIZING AND STOCK CUTTING PROBLEMS

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Abstract: The goal of this work is to propose the application of a mathematical model, which couples the lot sizing and stock cutting problems, to a real case of a factory, in order to minimize the production costs. Two final products of the manufactory are considered. Costs and demands vary over periods of planning. Numerical results from this study are compared with the case whose production is made considering the demand by period. The optimal solutions obtained from the model are promising, since they provide a considerable profit in relation to the production by demand.

keywords: Modeling, Optimization, Numerical Simulation, Lot sizing, Stock cutting.

Magnetohydrodynamic equilibria with gravitational forces in symmetric systems

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Abstract: We present a general formulation for magnetohydrodynamic static equilibria with external forces in symmetric systems with one ignorable coordinate, with emphasis on the gravitational field. Particular solutions are presented for rectangular, cylindrical, and spherical coordinates.

keywords: Celestial Mechanics and Dynamical Astronomy, Fluidodynamics, Plasma and Turbulence, Geophysical Nonlinear Dynamics

Fractal structures in a model for E x B drift motion of charged particles in magnetized plasmas

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Abstract: We describe the formation of fractal structures in the Poincaré surface of section for a model describing the **E x B** drift motion of charged particles interacting with two electrostatic waves, in a magnetically confined plasma. These fractal structures have important consequences for the transport properties of particles and energy.

keywords: Chaos and Global Nonlinear Dynamics , Fluidodynamics, Plasma and Turbulence , Nonlinear Dynamics and Complex Systems

Thermal Lattice Boltzmann Method for Dilute Fluids of Bosons and Fermions

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Nearly twenty years ago a numerical method was developed to solve the Boltzmann equation with the BGK (Bhatnagar, Gross and Krook) collision. This method, based on the discretization of the phase space, was very successful in solving various problems of fluid mechanics, including problems with complex geometry, interfacial phenomena and multicomponent fluids. Known as LBM – Lattice Bolztmann Method – it describes the evolution of a set of statistical distributions of particles defined on a regular space lattice in which each site has a finite number of velocities directed to neighboring sites. The advantage over other methods lies in the simplicity of its dynamics and especially the flexibility for implementation in parallel computing. Although the LBM breaks the translational invariance in the mesoscopic scale, it leads to the expected hydrodynamic equations in the continuous macroscopic scale, such as conservation of mass and momentum (Navier Stokes). In recent years there has been a great deal for the construction of an LBM able to describe compressible and thermal fluids, which also carries the description of energy conservation.

In this work we develop the LBM for the treatment of semi-classical, i.e., those such that the particle distributions describe bosons or fermions. We show that the LBM for thermal and compressible classical fluid, described by the Maxwell-Boltzmann statistics, and the LBM for semi-classical, described by the Bose-Einstein and Fermi-Dirac statistics, are based on the same mathematical structure. Both cases require the expansion to fourth order of the equilibrium distribution functions in Hermite polynomials, in such a way to reproduce a consistent thermodynamics. Once done this fourth order expansion we obtain the correct macroscopic equations describing the quantum fluid, i.e., the equation of conservation of mass, momentum (Navier-Sokes) and energy. From these equations we retrieve the well-known coefficients of viscosity and thermal conductivity. As an application, we do numerical simulations for diluted semi-classical particles with periodic boundary conditions considering different initial conditions

Keywords: Fluid dynamics, Plasma and Turbulence; Modeling, Numerical Simulation and Optimization; Nonlinear Dynamics in Thermal and Fluid Sciences

Identification of a nonlinear beam through a stochastic model based on a Duffing oscillator.

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Abstract: The mathematical models of mechanical systems depends on the identification of modal parameters and some nonlinear behavior that could be considered to predict de output. Unfortunately, experimental measurements are full of uncertainties that have to be taken in account in these models. Thus, this work proposes a model of a nonlinear beam as a Duffing oscillator. The modal parameters of the linear equivalent systems and the nonlinear stiffness are estimated by stochastic methods considering the restoring force surface method. The parameters probability density functions (PDF's) are estimated of nonparametric way and a stochastic model is obtained with confidence limits to the responses. The model is validated with new experimental data through Monte-Carlo simulations. The results have been shown the capability to describe the nonlinear behavior of the beam considering uncertainties quantification.

keywords: Stochastic Models; Modeling, Numerical Simulation and Optimization; Nonlinear Dynamics and Complex Systems; Duffing Oscillator.

Investigating the Origin and Behavior of Spontaneous Activities of the Brain with Optical Methods

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Abstract: Measuring cerebral dynamics during the resting state has been a useful approach to explore the brain's functional organization. Here we employed graph theory and a neuroimaging technique (near-infrared spectroscopy/NIRS) to provide insights of spontaneous activity (SA) in the human brain. Our results suggest that global network parameters derived from NIRS are reliable to characterize the brain's SA. In addition, huge clusters and long-range links were found among brain areas that are symmetrically located and that share same functionality. Last, SA network features can be successfully simulated from the Ising model at the critical temperature.

keywords: Complex Networks, Nonlinear Dynamics and Complex Systems, System Biology, Time Series Analysis.

Perturbative methods in agent based epidemic models

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Abstract: In the study of epidemics, two agent based models are often employed: the susceptible-infected (SI) and susceptible-infected-susceptible (SIS). Both models describe the time evolution of infectious diseases in networks formed by susceptible (S) and infected (I) agents. They assume Markovian behavior for disease transmission, agent recovery or diffusion of infectious agents throughout the underlying network. Predicting the effects of health policies in the disease spreading is one of the major goals in epidemic studies but often restricted to numerical simulations. Analytic formulations using operatorial content are subjected to the asymmetric eigenvalue problem, which restraints the use of perturbative methods. Here, we report how to employ the squared norm of probability vector, ||P(t)||^2 , to avoid the asymmetric time generators in general Markovian processes. This approach allows us to obtain one differential equation that describes the time evolution of probability vectors with non-holonomic constraints. From this equation, one algebraic equation for stationary states is derived, requiring only the eigenvalues of symmetrized time generator. Further analysis shows regular perturbative methods are available to ||P(t)||^2 and account for small parameter variations, without additional requirements.

keywords: Epidemiology and Mathematical Models; Stochastic Models; Complex Networks; Modeling, Numerical Simulation and Optimization

A Lattice Boltzmann Method for Electrons in Metals

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In the 80s a numerical method was developed to solve the Boltzmann equation with the BGK (Bhatnagar, Gross and Krook) collision term. This method, based on the discretization of the phase space, was very successful in solving various problems of fluid mechanics, including problems with complex geometry, interfacial phenomena and multicomponent fluids. Known as the LBM – Lattice Boltzmann Method – it describes the evolution of a set of statistical distributions of particles defined on a regular space lattice in which each site has a finite number of velocities directed to neighboring sites. The advantage over other methods lies in the simplicity of its dynamics and especially the flexibility for implementation in parallel computing. In recent years, there has been a great interest in the construction of LBM's able to describe fluids that are not described by Maxwell-Boltzmann distribution, like semi-classical fluids (described by Fermi-Dirac and Bose-Einstein distribution) and relativistic fluids (described, for instance, by Maxwell-Juttner distribution).

In this work we derive a general mathematical framework that leads to new LBM's associated to generic equilibrium distribution functions and we apply this model to electrons in metals. This framework is based on our discovery of a new polynomial basis in Euclidean space which yields the Hermite polynomial basis in the special limit that the weight function becomes the Gaussian function. The equilibrium function is expanded in this new basis and we discuss the order that must be considered to obtain the correct conservation laws. We also obtain the discrete lattices associated to the new polynomial basis. As an application, we construct a LBM capable of describing electrons in the Fermi surface and show some numerical simulations, as the shock tube test and the Poiseuille flow. This particular LBM is a very promising one since it could be used to describe the conduction of electrons in arbitrary geometries, something of interest in condensed matter and also in industrial applications.

Keywords: Fluid dynamics, Plasma and Turbulence; Modeling, Numerical Simulation and Optimization; Nonlinear Dynamics in Thermal and Fluid Sciences

A WEB FRAMEWORK FOR ADVANCED AND INTENSIVE NONLINEAR TIME SERIES ANALYSIS

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Abstract: Using the *e-Science* paradigm, computers play a key role in supporting scientific areas such as those using nonlinear time series analysis to understand seemingly unpredictable behavior. This work presents a web framework supporting researchers in this class of analysis in a cloud environment where they can access, parameterize, initialize and monitor their applications transparently. Moreover, new applications can be added and managed by researchers on the portal easily. As a case study, techniques such as detrended fluctuation analysis (DFA) and gradient pattern analysis (GPA) will be added and used for intensive time series analysis in the Brazilian Space Weather Program.

Keywords: Time Series Analysis, Nonlinear Dynamics and Complex Systems, Chaos and Global Nonlinear Dynamics, Web Framework, High-Performance Computing

Analysis of RR intervals time serie using second-order difference plot

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Abstract:

The RR interval time series is a descriptor for assessing cardic health. Amongst different nonlinear methodologies to analysis the RR intervals, the second-order difference plot provide a graphical representation of the degree of variability of time series. In total are analyzed 122 tachograms collected by Polar monitor and then classified into two groups: 61 healthy young adults and 61 adults in preoperative evaluation for coronary artery bypass grafting for severe coronary disease. This approach identified the tachograms with high and low variability, which demonstrates the ability of second-order difference plot to discriminates both groups of RR intervals time series.

keywords: Times series analysis, Nonlinear Dynamics and Complex Systems, System Biology, RR intervals.

Cluster formation dynamics of heterogeneous agents

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Abstract: This work studies the dynamic of particles under the influence of attraction and repulsion. The main objective is to analyze how the heterogeneity can affect the formation or dissolution of clusters. The dynamic of many particles is impossible to solve by analytical way, so computer simulation is essential. The particles are discs in a plane and similarity or antagonism among them is defined by their colors based on the RGB model. Particles are attracted if their colors are similar and repelled otherwise. The clusters are formed by non-elastic collisions.
We show some cluster patterns and results for different concentrations of 3 colors, by measuring the energy and the number of collisions during time.

keywords: Complex Networks, Stochastic Models, Numerical Simulations

Using two-dimensional continuous wavelet transform to detect differences among primary forest, water bodies, clouds and cloud shadows on remote sensing images of an Amazon rain forest: preliminary results

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Abstract:
One important issue in practical uses of remote sensing imagery is to map clouds and cloud shadows. Often the clouds can be confused with snow, sand or straw cover. Moreover, the shadows of the clouds can be confused with water bodies. In this way, we are using Two-Dimensional Continuous Wavelet Transform (CWT2D) in order to identify differences between primary forest, water bodies (lakes and rivers) and clouds and shadows clouds. The site is located at the Uatumã Reserve in Central Amazonia. We use CWT2D to detect per scale differences among patterns of the surface texture. The results show the existence of statistically significant differences among the distinct classes of areas mentioned above.

keywords: Time Series Analysis, Fluidodynamics, Plasma and Turbulence, Chaos and Global Nonlinear Dynamics

(**At least the first three keywords must be chosen among the following ones:**

- Analysis and Control of Nonlinear Dynamical Systems with Practical Applications
- Bifurcation Analysis and Applications
- Celestial Mechanics and Dynamical Astronomy
- Chaos and Global Nonlinear Dynamics
- Climate Dynamics
- Complex Networks
- Control in Complex Systems
- Control of Chaos
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- Geophysical Nonlinear Dynamics
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- Nonlinear Dynamics and Complex Systems
- Nonlinear Dynamics in Lasers
- Nonlinear Dynamics in Thermal and Fluid Sciences
- Nonlinear Dynamics of Systems with Infinite Dimension
- Nonlinear Fractional Dynamics and Applications
- Nonlinear Systems and Neural Dynamics

- Stochastic Models
- Synchronization in Nonlinear Systems
- System Biology
- Time Series Analysis

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ORDER-CHAOS-ORDER TRANSITION IN A SPRING PENDULUM

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Abstract: The dynamics of a spring pendulum varies according to its total energy and a parameter, called *f*, that accounts for its physical characteristics: pendulum mass, spring stiffness constant and spring unstretched length. We build the Poincaré sections of the system and we analyze the order-chaos-order transition that it undergoes as we increase the total energy. We observe that this transition happens irrespective of the value of the parameter *f*. On the other hand, as we increase *f*, we verify a bifurcation pattern that occurs whenever the total energy of the system is below a threshold value.

keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Bifurcation Analysis and Applications, Chaos and Global Nonlinear Dynamics.

Effect of plasticity on the neuronal firing

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Abstract: In this work, the main goal is the study of the effect of plasticity on the neuronal firing in a network modeled by means of celullar automata. Cellular automaton is a mathematical model that presents a finite set of states, where the space and time are discrete. To model the interactions among the neurons we have used deterministics and non-deterministics rules, as well as the neuronal interactions are described through chemical and electrical synapses. In addition, plasticity and time delay are only considered in the chemical synapses. Our results, without plasticity, show that the addition of chemical synapses may contribute to improve the system sensibility on the external perturbation, in other words, to increase the value of the dynamic range. In this case, we also verify the existence of bistability regions of the average rate firing when the values of the external perturbation is varied. When the plasticity is considered, we have also observed the possibility of existence of bistability.

keywords: Complex Network, System Biology, Cellular Automata, Firing Rate.

TITLE: Using micro and nanoresonators as pseudo-random numbers generators

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Abstract:

In this study, we propose a protocol to investigate how good can be a MEMS/NEMS resonator, builded in two different architectures, as a mechanical pseudo-random numbers generator (PRNG). Such proposition has appeared in the literature after the work done by Chen et. al (2010), where the authors claim that such resonators cannot generate a sequence with genuine randomness, making them poor PRNGs. However, results obtained in our previous work suggest otherwise and in this presentation we extend such results acquired for a double-sided electrode resonator and repeat the investigation to an one-sided electrode as well. This last case has a route to chaos very similar to the route displayed by the logistic map, a well known chaotic system used as a good PRNG.

Keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Chaos and Global Nonlinear Dynamics, Nonlinear Dynamics and Complex Systems.

Properties of agent based epidemic models using coherent states

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Abstract: Epidemic models may describe the time evolution of infectious diseases formed by susceptible (S) and infected (I) agents, connected according to the underlying graph or network. The transmission of the disease among the agents and agent recovery over time are mapped into well-defined Markovian processes. Despite the vast amount of research and results using compartmental models, the role played by fluctuations is often neglected or restricted to numerical Monte Carlo simulations. Analytic formulations for fluctuations in epidemics are rare since the operatorial content is subjected to the asymmetric eigenvalue problem. Here, we study fluctuations for the squared norm of probability vectors in the SIS model, as shown in another work in this conference. In this formulation, the time evolution of squared norm is governed by the symmetrized Markovian time generator. The Holstein-Primakoff transformations are applied and the time generator is expressed using bosonic creation and destruction operators in the Fock space. We show coherent states are suitable candidates to describe the number of infected agents and their fluctuations over time.

keywords: Epidemiology and Mathematical Models; Stochastic Models; Complex Networks; Modeling, Numerical Simulation and Optimization

DYNAMIC OF NEURONAL MEMBRANE USING A NUMERICAL MODEL

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Abstract: Hodgkin and Huxley model describes the electrophysiology of the membrane of the giant squid axon and it was developed from measurements of passive and active electrical behavior of the nerve cell. Based on the behavior of sodium and potassium channels, the model consists of four coupled nonlinear ordinary differential equations. This study's objective is to study the dynamic behavior of a neuronal physiological system described by the Hodgkin-Huxley model through the analysis and interpretation of numerical simulations.

keywords: Modeling, Numerical Simulation and Optimization, System Biology, Time Series Analysis, H-H model, Nerve cell.

Periodic Control Applied to the Attitude Control of the Serpens II Mission

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keywords: nonlinear dynamical systems, modelling, numerical simulation, periodic control.

The number of small satellite projects has considerably increased in the past years, even more owing to the CubeSat-class standard which has drawn the attention of several universities and industry around the world. Usually, small satellites are designed for Low-Earth Orbit (LEO) missions and, due to dimensional limitation, low-cost budget and available technologies, these satellites are limited in terms of instrumentation. Considering this scenario, the magnetic actuation becomes appreciable for attitude control. In this case, electromagnetic devices are used to perform the corrective maneuvers. However, it is well known that the Earth's magnetic field (EMF) is time-varying along the orbit and the interaction between the EMF and the electromagnetic actuation introduces uncertainties and nonlinearities on the system. The effects directly hamper the performance of the controller and, in such cases, the system is said underactuated. In order to address this problem, this work aims to consider a periodic control design taking into account the periodicity of the EMF along several orbits. As for the system, it is considered the SERPENS II satellite model which consists in a 3U CubeSat project conducted by Brazilian universities with international cooperation and sponsorship from the Brazilian Space Agency (AEB – in Portuguese). Following the methodology presented in literature, it is intended to design a periodic and robust controller. Simulation results will consider a simplified model and more realistic models of the satellite in order to validate the viability and robustness of this approach.

TESTING ANOMALOUS DIFFUSION MODELS FOR SIMULATION OF COSMOLOGICAL DENSITY FLUCTUATION SPECTRA

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Abstract: The hypothesis of non-Gaussian stochastic processes in cosmology has become important in the study of the structure formation in hierarchical scenarios. In this work we present the application of anomalous diffusion models (especially KPZ-equation and equivalents automata) to simulate density fluctuation spectra in the Lambda-CDM cosmology. The models are tested in the following ways: fluctuation maps are generated serving as initial conditions in large-scale structure formation. The Anomalous Diffusion spectra are validated based on the statistical properties of voids and filaments obtained for low redshifts (z < 1).

- **keywords**: Topics: Stochastic Models; Celestial Mechanics and Dynamical Astronomy; Nonlinear Fractional Dynamics and Applications; Nonlinear Dynamics and Complex Systems; Cosmology.

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- Nonlinear Fractional Dynamics and Applications
- Nonlinear Systems and Neural Dynamics
- Stochastic Models
- Synchronization in Nonlinear Systems
- System Biology
- Time Series Analysis

Gradient pattern analysis of coupled map lattices

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Description: A modified computational operator for Gradient Pattern Analysis is introduced into the framework of 2D-Coupled Map Lattices. The GPA coefficient is computed taking into account different sizes and boundary conditions for characterization of chaotic 2D-CML. In addition to quantifying concentric asymmetries, GPA measures the phase disorder associated with a given pattern. Simulations of chaotic CML using Gaussian and random initial conditions, provide interesting insights on the system gradual transition from order (concentric symmetries) to disorder (emergence of concentric asymmetries).

keywords: Time Series Analysis, Chaos and Global Nonlinear Dynamics, Discrete Dynamical Systems.

THE LOCAL DYNAMIC EFFECT ON FREQUENCY SYNCHRONIZATION OF NEURONAL NETWORKS

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Coupled bursting neurons can exhibit frequency synchronization when the coupling strength is increased above a certain value. The process that makes different frequencies converge to the same value depends on the coupling type and the local dynamic. If we compare two different models of neuronal network they can exhibit the same phase synchronization profile, however they might suffer frequency synchronization differently. While topology is the main focus on synchronization studies, here we show that local dynamic also plays an important rule in synchronization process [a].

keywords: bursting neurons, frequency synchronization, topology.

[a]FAS Ferrari, RL Viana, F Gomez, T Lorimer and R Stoop. *Macroscopic bursting in physiological networks: node or network property?*. New Journal of Physics, v. 17, p. 055024, 2015.

COMPLEX DYNAMICS IN AN ELECTROCHEMICAL N-NDR OSCILLATOR

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Abstract: Electrochemical systems are paradigmatic examples of nonlinear kinetics and thus used to investigate complex dynamics in reacting media. This is of particular importance due to the combination of experiments and numerical modeling. An important class of electrochemical oscillator is the so-called N-NDR, which consists of negative differential resistance in an N-shaped current potential curve. Very interesting sequences of mixed oscillations were found in the experimental reduction of indium(III) on a mercury electrode in concentrated sodium thiocyanate solution, and modeled by a Koper and Gaspard (M.T.M. Koper, P. Gaspard, *J. Chem. Phys.* **96** (1992) 7797). Herein we report an extensive numerical investigation of this three-variable and nine-parameter model. The control space of the model displays a number of remarkable phenomena that we describe in detail for the first time.

keywords: Nonlinear Dynamics and Complex Systems, Mixed Mode Oscillations, Chemical Systems, Electrochemistry.

Regime shift in a model for vector transmitted disease epidemics

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Abstract: We have devised a mathematical model for epidemics in which the disease is transmitted by a vector such as a mosquito. A set of discrete time equations describe the time evolution of the vector age structured population. Crucial parameters such as birth and mortality rates are made temperature dependent.
The effect of climate change on the vector life cycle is simulated by allowing the parameters to vary with time in a way that reflects the underlying temporal variation of temperature. This is accomplished by feeding the model with a temperature time series (TTS) which allows us to express the temperature dependent parameters as functions of time. In order to investigate the epidemic dynamics this model is coupled to a SIS model. We simulate different scenarios for the vector development and epidemic evolution by manipulating the average temperature of the TTS. The resulting time series of vector and infected individuals populations display two distinct behaviors depending on the average temperature Tm of the TTS: low (high) values and low (high) amplitude fluctuations for Tm below (above) Tl , the threshold temperature for the development of a sustainable population of infected individuals when the temperature is kept constant. The power spectra of resulting time series of infected individuals exhibit $1/f^{\gamma}$ behavior with γ depending on Tm : it decreases steadily with Tm until Tl is reached, then suffers a sharp decrease and remains constant for Tm > Tl. This bottom value of γ depends on the parameter α in the SIS model that is inversely proportional to the recovery time from the disease. Our simulations suggest that as α increases the exponent γ tends to 1.0, which is the signature of the 1/f noise. Our claim is that 1/f noise arises in this model as a consequence of separation of time-scales in the model, since the recovery time becomes much smaller than the time scale of the vector cycle for α large enough. We also apply this model to dengue epidemics with empirical data for the mosquito life cycle and a real temperature time series.

keywords: Epidemiology and Mathematical Models, Time Series Analysis, Discrete Dynamical Systems.

Experimental results of the Chua's circuit

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Abstract: In this work, we obtained experimentally two-dimensional parameter spaces of periodicity and the largest Lyapunov exponent for the Chua's circuit using the time series measurements for different values of resistors rL in series with the inductor and R connecting the two capacitors. Two digital potentiometers with 1024 steps with 0,100Ω and 0,200Ω stepsize were built to modify the values of these parameters. The data acquisition and the control of the digital potentiometers were made through a software developed in LabView. The data analysis and the presentation of results were performed using python scripts. The results were compared to computer simulations and confirmed the presence of period-doubling cascade, periodic windows, period-adding route and periodicity hubs. We also verified attractors coexistence and crisis-induced intermittency in experimental bifurcation diagram.

keywords: experimental Chua's circuit, parameter space, periodic windows, Lyapunov exponent.

DISCRETE COMPLEX WAVELET APPROACH APPLIED TO PHASE SYNCHRONIZATION ON SOLAR PARAMETERS

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Abstract: In general for the space science, and in particular for the solar physics, the development of new nonlinear analysis methods is always interesting and a promising initiative, because most of the time dynamical aspects may be unraveled from the physical records. Much effort has been done to survey the dynamical behavior of the Sun described by physical parameters connected to complex non-linear mechanisms responsible for the energy release on the solar atmosphere. Discrete Complex Wavelet Approach (DCWA) is based on the phase assignment from complex wavelet coefficients obtained by using a dual-tree complex wavelet transform. Can DCWA be validate for phase assignment, and subsequently in the calculation of phase difference of solar parameters? For validation tests, two time series of important solar parameters are chosen: (1) the daily sunspot number, and (2) the daily total radio flux at 10.7cm, from 1999 till 2002, which corresponds to the maximum phase of the previous solar cycle. Initially, the DCWA allows us to find the frequencies that are present in those signals. The implemented method allows us to identify the preservation of synchronism along the time and the intervals related to phase-slips among them. The result indicates that both series are under synchronization almost all the time. This result is consistent with what we expect according with the physics of that problem. Indeed, the recorded daily sunspot number (of sunspots) is well related with the daily measured radio flux at 10.7 cm. The result found confirms what is well known from the literature that both parameters can be used as proxies for the solar activity. Also, this DCWA method is validated as a tool to analyze in a complete way the synchronization of a wider set of solar parameters.

Keywords: Analysis and Control of Nonlinear Dynamical Systems with Practical Applications, Fluidodynamics, Plasma and Turbulence, Synchronization in Nonlinear Systems, Phase Synchronization, Solar Parameters.

DYNAMICAL CHARACTERIZATION OF NONLINEAR SYSTEMS THROUGH COMPLEX NETWORKS

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Abstract: The dynamical characterization of nonlinear systems is a great challenge and it is usually performed by using Lyapunov exponents and bifurcation diagrams, which is not always an easy task. In this work, we present an approach for dynamical characterization using symbolic dynamics and complex networks. As an example, we apply the proposed methodology to the Logistic Map, as it is a paradigm of dynamical systems. Some properties of the networks generated by the time series match with the expected behaviors of the system. In other words, our methodology could identify periodic windows and chaos.

keywords: Chaos and Global Nonlinear Dynamics, Complex networks, Time Series Analysis, Logistic Map.

Energy distribution in a spring pendulum

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Abstract: We consider the dynamics of a spring pendulum as a function of its total energy and a second parameter accounting for the physical characteristics of the system. We analyze how the energy of the system is distributed between each degree of freedom. The energy distribution depends on the initial conditions and it is not constant in time. However, it presents well defined features. We also verify that the energy distribution preserves its characteristics for different values of the total energy, although the behavior of the system may change a lot according to this parameter.

keywords: Chaos and Global Nonlinear Dynamics, Time Series Analysis, Analysis and Control of Nonlinear Dynamical Systems with Practical Applications.

An Alternative Method for the Dimension Calculation of Fractal Basin Boundaries

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Abstract: There are currently two main methods used to calculate the dimension of fractal basin boundaries in dynamical systems, namely the *uncertainty method* and the *output function evaluation method*. We propose a new method that is based on the former one called the *conditional uncertainty method*. We show that the conditional uncertainty method can calculate fractal dimensions of basin boundaries to a good accuracy.

Keywords: Chaos and Global Nonlinear Dynamics, Nonlinear Dynamics and Complex Systems

Interaction of scroll waves in an excitable medium

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Key words scrolls, arrhythmia, reconnection, interaction, Belousov-Zhabotinsky reaction
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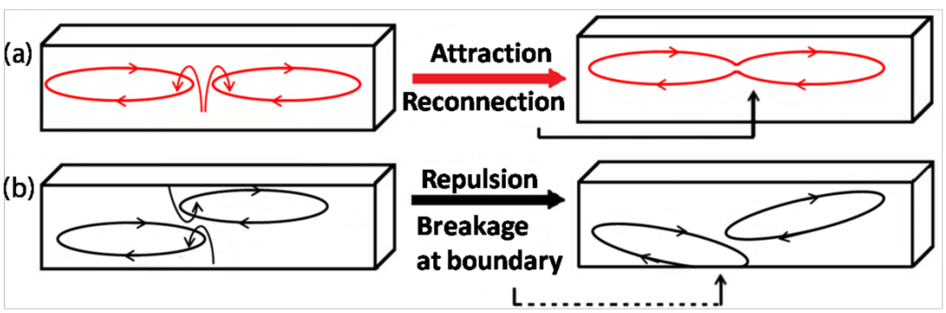
Scroll waves are 3D counterparts of spiral waves that rotate around a one-dimensional space curves, known as its filament [1]. Their presence in the cardiac tissues is many times the cause of arrhythmia that finally leads to heart failure [2]. Interaction of scroll waves may have far-reaching consequences on cardiac activity. In fluids and liquid crystals, there is evidence of vortex interaction leading to interesting phenomena like filament reconnection [3, 4]. If likewise, scroll rings interact and reconnect, then small rings may merge and form large ones that will have enhanced life-times.

Here, we report the first experimental evidence of scroll wave reconnection in Belousov-Zhabotinsky reaction. Our results demonstrate that when two scroll rings are brought close enough, they can either attract each other, and reconnect to form a large scroll ring, or they can repel so that they rupture on touching the boundaries. We also carry out simple numerical simulations using Barkley model that helps explain the filament behavior in our experiments.



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