CHAOS 2011

Book of Abstracts

4th Chaotic Modeling and Simulation International Conference

Editor

Christos H. Skiadas

May 31 - June 3, 2011

Agios Nikolaos, Crete Greece

Introduction

4th Chaotic Modeling and Simulation International Conference

Agios Nikolaos, Crete (Greece) May 31 - June 3, 2011

It is our pleasure to welcome the guests, participants and contributors to the 4th International Conference (CHAOS2011) on Chaotic Modeling, Simulation and Applications. We support the study of nonlinear systems and dynamics in an interdisciplinary research field and very interesting applications will be presented. We intend to provide a widely selected forum to exchange ideas, methods, and techniques in the field of Nonlinear Dynamics, Chaos, Fractals and their applications in General Science and in Engineering Sciences.

The principal aim of CHAOS2011 International Conference is to expand the development of the theories of the applied nonlinear field, the methods and the empirical data and computer techniques, and the best theoretical achievements of chaotic theory as well.

Chaotic Modeling and Simulation Conferences continue to grow considerably from year to year thus making a well established platform to present and disseminate new scientific findings and interesting applications. We thank all the contributors to the success of this conference and especially the authors of this *Book of Abstracts* of CHAOS 2011.

Agios Nikolaos, May 2011

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Keynote Talks

Marisa Faggini
University of Salerno, Italy
Chaos Theory: Implications for Economic Analysis

Oded Gottlieb
Department of Mechanical Engineering, Technion - Israel Institute of Technology, Haifa, Israel
Chaos and multiple mode spatio-temporal complexity in thermo-visco-elastic systems subject to laser irradiation
Co-author:

Hansjorg Kielhofer
University of Augsburg, Germany
Pattern Formation of the Stationary Cahn-Hilliard Model

Vic J Law
Dublin City University, National Center of Plasma Science and Technology, Dublin, Ireland
Decoding of atmospheric pressure plasma emission signals for process control
Co-authors: D P Dowling, J L. Walsh, F Iza, N B Jonson, and M G Kong

Alexander G Ramm
Department of Mathematics, Kansas State University, USA
Stability of solutions to some evolution problems

Leszek Sirko
Institute of Physics, Polish Academy of Sciences, Warszawa, Poland
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Institute of Mathematics, Utrecht, The Netherlands
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Chaos and control in semiconductors

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The perturbation of external periodical signals on dynamical nonlinear systems demonstrating chaotic behaviour has been investigated experimentally. The regions of chaotization and ordering of systems have been found.
Keywords: Chaotic behaviour, Ordering, Current-voltage characteristics, Time series, Phase portrait, Power spectrum.

Inverse Structural States of the Stochastic Deformation Field of Fractal Dislocation

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The new structural states of fractal dislocation are investigated on the basis of fractional calculation theory and Hamilton operators. In order to describe the behaviour of the stochastic deformation field of fractal dislocation within the framework of the statistical approach, average complex functions are introduced. The numerical modelling of the complex deformation field behaviour is fulfilled on a rectangular discrete lattice. It is shown that for inverse (with a negative fractal index) states of fractal dislocation there is an interval of change of this index with anomalous behaviour of the deformation field: there is no effective attenuation within the interval. The introduced functions allow to reduce the presence of quantum and unusual statistical properties of the deformation field.
Keywords: fractal dislocation, stochastic deformation field, numerical modeling, statistical properties, inverse structural states.

Self-organization and Alteration of the Structure of the Stochastic Deformation Field of Fractal Dislocation

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In order to describe the structure of stochastic deformation field, the basic nonlinear equations taking into account a variable fractal dimension in planes parallel to the plane of basic rectangular discrete lattice are obtained. By the numerical modeling method a possibility to govern the alteration of the structure of the stochastic deformation field of fractal dislocation by means of constant and variable (accounting the process of self-organization) parameters is

shown. Self-organization is accompanied by the distortion of the basic stochastic state of the deformation field on the whole rectangular lattice or it leads to the occurrence of a structural state with fractal dislocation.
Keywords: fractal dislocation, stochastic deformation field, numerical modeling, self-organization, alteration of the structure.

Chaos Synchronization and Chaos Control Based on Kannan Mappings

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In this paper, a new method for constructing chaotically synchronizing systems is proposed. Furthermore, a new control method for stabilizing a periodic orbit embedded in a chaotic attractor is proposed. The validity of these methods is shown by a property of Kannan mappings. It is shown that in some cases in which method of contraction mappings, proposed by Ushio (T. Ushio. Chaotic Synchronization and Controlling Chaos Based on Contraction Mappings, *Physics Letters A*, vol. 198, 14-22, 1995.), cannot be applied to synchronize or control of chaotic systems, the method may be applied. Ultimately, a numerical example is given in order to present the results established.
Keywords: chaos synchronization, chaos control, Kannan mappings.

On the Computation of the Kantorovich Distance for Images

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We consider the theory and applications of the Kantorovich metric in fractal image compression. After surveying the most important approaches for its computation, we highlight its usefulness as a mathematical tool for comparing two images and improve its performance by means of more appropriate data structures.
Keywords: Fractals, Hutchinson metric, Image comparison, Kantorovich metric.

On a Physical model for Alzheim-2er's Disease

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We present a physical model for explaining the disruption of neuronal activity in the case of Alzheimer’s disease. We show that an indirect coupling

through amyloid beta oligomer, when added to the normal synaptic coupling can lead to neuronal silencing and demonstrate this using a small network of Hindmarsh- Rose model of neurons.
Keywords: Alzheimer's disease, indirect coupling through amyloid beta.

Dynamics and coupling of ODE and PDE FitzHugh-Nagumo neuron models

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The FitzHugh Nagumo model (1) is well known for reproducing both features of excitability and periodicity. Recall that this model can be seen as a simplification of Hodgkin-Huxley equations, which describes a neuron behavior considering the main ions uxes.

$$\begin{cases} \epsilon \dfrac{du}{dt} = -u^3 + 3u - v \\ \dfrac{dv}{dt} = u - c \end{cases} \tag{1}$$

In system (1), the first variable u represents the difference of potential between extra-cellular and intra-cellular environment, called the membrane potential. The second variable, υ, is a recovery variable representing the movement of different ions.
Mathematically, this system provides two kind of behaviour depending on value of the parameter c:

- evolution to a stable stationary point with eventually an excitable phase
- evolution to a stable limit cycle.

By using these features, the adding of spatial dimension (see system (2)) and terms of diffusion leads to complex patterns, relevant for both mathematics and biology: wave propagations, spirals, mixed mode oscillations...

$$\begin{cases} \epsilon \dfrac{du}{dt} = -u^3 + 3u - v + \Delta u \\ \dfrac{dv}{dt} = u - c + \Delta v \end{cases} \tag{2}$$

Some of these behaviour exhibited by system (2) are already found in two coupled systems of type (1). This observation allows a wide range of mathematical ques-tions, one of which is: what can we expect if coupling systems of type (2)?
This talk adresses a review of some results on systems (1) and (2) and tries to give some elements on arising questions.
Keywords: FitzHugh-Nagumo model, Slow-Fast Oscillations, Coupling, Nonlinear Dynamics.

Routes to chaos in confined thermal convection arising from a cylindrical heat source

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In the present study, bifucations and chaotic behaviours of natural convection flows generated by a confined thermal source are addressed.
Buoyancy-induced flows in enclosures may be very complex in nature, and their main characteristics are highly unpredictable. This is partially inherent in the bi-directional interaction between the flow and temperature fields, which is reflected in the structure of the system of partial differential equations governing the problem, but also derives from the sensitivity of the thermal-flow regimes to the geometric and thermal configuration of the system.
The importance of bifurcations and chaos in buoyancy-induced flows as a research topic goes far beyond the field of thermal sciences. In fact, it is deeply entwined with the history of chaos theory, since the discovery of the renown Lorenz attractor, originating from a simplified Rayleigh-Bénard convection model. From that seminal study, many works have been carried out on the non-linear dynamics of thermal convection in basic enclosure configurations, such as the rectangular enclosures heated from below and from the side, and, more recently, the horizontal annulus between two coaxial cylinders.
The physical system considered in the present study is the cavity formed by an infinite square parallelepiped with a centrally placed cylindrical heating source. The system is approximated to its 2D transversal square section containing a circular heat source. The resulting flow is investigated with respect to the leading parameter of the non-dimensionalized problem, the Rayleigh number (Ra), and for two values of the aspect ratio A=L/H between the cavity side length (L) and the enclosure to cylinder gap width (H). The third parameter of the system, the Prandtl number, is fixed at a value Pr = 0.7, representative of air at environmental conditions.
The governing partial differential equations are solved by means of a second order finite-volume discretization on orthogonal Cartesian grids. Boundary conditions on non-aligned contours are handled by introducing appropriate corrective terms in the discretized equations.
The sequence of bifurcations marking the transition of the base flow solution to unsteady, chaotic flows is followed for each of the two A-values, by means of numerical simulations. It is observed that, for the lower A-value, the route to chaos is triggered by a supercritical Hopf bifurcation, corresponding to an instability of hydrodynamic type, while, for the higher A-value, the symmetry of the system is broken by a pitchfork bifurcation, much alike to the classical Rayleigh-Bénard case.

Stochastic Parametrisation and Model Uncertainty in the Lorenz '96 System

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Simple chaotic systems are useful tools for testing possible methods to use in numerical weather simulations due to their transparency and computational cheapness. The Lorenz (1996) toy model of the atmosphere was used in this investigation, which describes a set of coupled large and small scale variables arranged in a ring.
Stochastic parametrisation of sub-gridscale processes can be used to explore model uncertainty. For each state of the resolved, macroscopic variables there are many possible states of the unresolved variables. It therefore seems unjustified to assume a one-to-one mapping of the large scale onto the small scale variables, as is the case in a deterministic parametrisation. A stochastic scheme is able to explore other nearby regions of the attractor compared to a deterministic scheme, and an ensemble generated by repeating a stochastic forecast gives an indication of the uncertainty inherent in the parametrisation process. A number of different stochastic parametrisation schemes were investigated, including the use of additive and multiplicative noise. Skill scores were used to give a measure of the forecasting ability of different parametrisations, and their forecasting skill compared to their ability to reproduce the climatology of the full model. This concept is of great importance in a seamless prediction system, allowing the reliability of short term weather forecasts to provide a quantitative constraint on the reliability of climate predictions from the same system.

References:
Lorenz, E. N., 1996, Predictability – a problem partly solved. Proceedings, Seminar on Predictability ECMWF, 1, 1-18.

Forecasting semiconductor sales by a neuro-fuzzy technique

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The semiconductor industry plays an important role in the growth of the economies worldwide, specially, in societies where the technology of computers is developing rapidly. This is the reason why the forecasting of their sales is a crucial issue for the financial and market analysts. In this paper, an Adaptive Neuro-fuzzy Inference System (ANFIS) system is used in order to forecast semiconductor sales, using data that concern monthly sales. The results are encouraging and prove that the model is efficient and easily applicable.

On Some Nonlinear Elliptic Problems with non standard growths

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In this paper, we establish the existence of a T - p(x) - solution for the following p(x) - elliplic problem:

$$-div\big(a(x,u,\nabla u)\big) = F \ in \ \Omega$$

Keywords: Sobolev spaces with variable exponent, truncations, elliptic problem, image processing, electrorheological uids, Minty lemma.

The Development of a Sound in a Child's Speech: Chaotic or Patterned?

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A child's speech from onset to age 4;6 was recorded on a daily basis. Focus is on the development pattern of individual sounds and, in particular, consonants. The child's intended production of a consonant is followed longitudinally in time. The correct productions of the target sound as well as its produced substitutes constitute the data under examination. The percentage of correct to total productions is plotted versus the child's age. When the increase in age is in terms of one day or a few days, the development of the partial acquisition of the sound exhibits chaotic behavior. However, when two or more weeks are considered as the increase in the child's age, it is observed that the sound's development may be described by a pattern with basically three distinct stages. In the first stage, the child's speech production shows a gradual improvement. In the second stage, there is an oscillating behavior with no overall improvement, while in the third stage there is again a gradual improvement until adult-like speech. It should be noted that there exists an extra stage prior to the first stage if the initial productions are correct. During this stage, there is a gradual worsening of the child's speech. The overall development characteristics are independent of the choice of consonantal sound and hold whether they correspond to the productions of one word or all the words containing the sound. However, the rate and the time span of progression or regression is very much lexical dependent.
Keywords: phonological development, linguistics, longitudinal case study, child speech, speech sound, speech productions, consonants, child speech statistics, chaotic speech development, patterned speech development, phonological acquisition, language acquisition

Modeling the Development of a Sound in a Bilingual Child's Speech

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The development of a child's speech sounds in two languages, English and Greek, acquired simultaneously from onset to adult-like is examined. Attention is paid on the dependence of the frequency of correct productions of an intended speech sound of each language at a specific age on the frequency of correct productions or on total productions of preceding age. The age is defined within a few days up to within a month. The results show that there is a non-linear relationship between developing speech productions which yields either a chaotic or patterned shape of development with increasing age of the bilingual child. When speech productions are counted bimonthly or less frequently, there is no chaos resulting in a shape of development that generalizes the well known U model of learning in psychology, correct-wrong-correct productions. For this non-chaotic case and for a time period of a few months in the middle stage of development, the non-linear relationship is depicted by a circle yielding a sinusoidal variation on the generalized U developmental curve. Cumulative correct speech productions are also considered from the beginning to each age inclusive in order to compare their development with the sigmoid curve representative of development in other phenomena of social and physical sciences. The results are by and large independent of the sound and the language considered within bilingualism.
Keywords: modeling phonological development, child speech, speech sound, speech productions, child speech statistics, chaotic speech development, nonlinear speech development, phonological acquisition, language acquisition, bilingualism, bilingual child

The Solutions Of Some Extremely Problems In Economics And Physics By Methods Of Linear And Nonlinear Wave Dynamics

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In modern science the most important problems represent considerations of unsteady irreversible processes in physics, biology, economy, psychology of personality, where there are, after loss of stability of linear solution for leading parameter of processes in bifurcation points, on empiric curves of processes, abrupt transitions from latent slow variation regions of parameters to almost deterministic large variation regions of parameters. The last ones we describe by nonlinear diffusion equations for probabilities. Using their solutions in

form of probabilities shock waves together with empiric data for 3 characteristic parameters of 12 countries, i.e. for 36 curves of economic parameters, we propose model of prediction of economic crisis. The same methods can be used in model of prediction of earthquakes. Also we solved nonlinear variant of known linear equation ,,Black- Sholes'' for options on market, obtained analytical and numerical solutions of them in cases of pure shock waves, neglecting term with volatility, as well as, for full nonlinear diffusion mentioned equation and constructed tables for options. These investigations allow describe mentioned processes more accurately than by linear theory, essentially in extremely regions.
Also are investigated by methods of nonlinear wave dynamics processes of transitions in fluid motion to turbulence by series of self-organized nonlinear flows by Landau-Lifshits and in Benar problem due to treatment of Haken.
Besides we investigate spatial-temporal nonlinear waves processes in physics on account fluctuations, by constructing and solving nonlinear functional Fokker-Plank-Haken equation for probability. In laser physics there is problem of generation shock wave propagation, which destroying the captive state of light i.e. breaks down work of devices of quantum informatics. We use relations on shock waves of destruction of adiabatic captive state of light for parameter of nonlinear laser processes, obtained by Lighthill-Whitham in gas-dynamics and obtain law of propagation of shock and parameter jump on it. We also apply method of nonlinear shock waves in analogous extremely genetic process of abruptly formation of fag-4 with same simulations. In our all investigations we follow the main conception that our world is nonlinear and self-organizing as in natural sciences, as well as in ethics of personality. And main method of our investigations of all these processes is application of our results on space-time problems for linear and nonlinear waves in continua.

The application of nonlinear wave dynamics methods to problem of Benar in horizontal layers of fluid and to semiconductors

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The investigation of stochastic processes in physics, economics, biology by modern nonlinear treatments is actual mathematical statistics aim. In former report we made it by application of methods of nonlinear wave dynamics in biological processes. The results are also obtained in our last investigations of extremely problems of generation of economic crisis, to solution of nonlinear "Black-Sholes" equation for options in markets. In present report we do same contribution of nonlinearity in known Fokker-Plank functional equations for probabilities of fluid dynamics and semiconductors problems the main attention is related to last stationary state probability determination.
Keywords: Benar problem, semiconductors, stationary flows, probability, nonlinearity.

The discussion of possibilities of application of methods of linear and nonlinear wave dynamics to probabilities determination in wandering problems

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In modern mathematical statistics there are different methods for improvement of linear normal distribution of probabilities of stochastic processes in extremely regions of parameters. In our last articles is made application of methods of nonlinear wave dynamics to analytical solution of non-linearised diffusion equations for probabilities whose coefficients are obtained from experimental data of stochastic processes and are done their solutions in application to biology, economics, physics. In present report are considered problems of traffic motion in deterministic treatment and on account randomness. In first case are investigated distributions on machines on road using Lighthill-Whitham solutions including shock waves, determination of stopping points and bottleneck. One can take into account also diffusivity and obtain solutions of nonlinear smoothed by diffusivity shock waves. Besides there are important problems of behavior of transport currents at cross-roads of different roads intersection and obtain conditions of absence of conflict situations. These problems formerly were investigated using normal distribution for probabilities of interaction processes of two parameters of transport flow, which is similar to problem of conflicts of two aircrafts collisions. As in last problem we add nonlinear term in known linear diffusion equation for probability on conflict situations and solve this equation for one parameter case, two parameter case in extremely regions can be reduced to one summary parameter case.
Then we replace in all known formulae of solution instead of Gaussian linear solution our analytical nonlinear solution. The same procedure we apply to problems of determination error probability for information channels. In all mentioned problems we use nonlinear waves method to examination of statistics of two or multi-parameters wandering problems.
Key-words: nonlinear diffusion equations, traffic flow, probabilities, information nets, wandering problems in plane.

Excitations in the net fractal systems

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Among the variety of fractal systems the concept of "net fractals" was developed [1]to describe systems which exhibit different scaling for each space direction see e.g. [2].The most elementary property is that in the logarithmic scale the "net fractals" becomeisomorphic with some solid crystals [1]. In our contribution we will use solidstate analogy to study excitations in the net fractal

systems. Both cases offree boundaries and tethered net fractals are considered. We prove that there are twotypes of excitations which using the analogy to the solid state can be called as "optic" and "acoustic" fractons. With the help of fractional calculus we findsolutions of the respective wave equations in terms of the Mittag-Lefflerfunctions. Finally we will illustrate it with some plots.

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Competition of chaotic and automodulation regimes in phase lock loops with the second-order filter and delayed feedback

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Dynamics of a phase-locked loop with the second-order filter and delayed feedback in the control circuit is studied using computer simulation. It is shown that the space of parameters can be globally divided into the regions where one of the two factors - either complexity of the filter, or feedback delay - dominates. The regions are separated by the minimum of the Andronov-Hopf bifurcation curve. In the regions, we identify parameter intervals, where regular (simple or complex) or chaotic automodulation oscillations exist and are globally stable. Time and frequency domain characteristics of the automodulation oscillations are investigated.

Keywords: phase-locked loops, dynamics regimes, synchronization, bifurcations, chaos.

On Nonlinear and chaotic behavior of a simples portal frame, under excitation of a unbalanced DC motor with limited power supply, coupled to a nonlinear essentially oscillator

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In this paper, we investigated the mitigation of vibration of a non-ideal structure (NIS) (simple portal frame under the excitation of a unbalanced DC motor with limited power supply) by means of a nonlinear sub-structure with properties of nonlinear energy sink (NES) and relatively small mass. We dealt with the numerical simulation of the (NIS), coupled to a nonlinear essentially oscillator (NES). We introduce the kinetic energy of the DC motor to investigate the pumping phenomenon, in the passage through resonance. Considering (NES) as vibration absorber, we can to reduce drastically the amplitudes of

oscillations of (NIS) and to reduce the Sommerfeld effect in the passage resonance region.
Furthermore, the proposed (NES) of nonlinear type is quite effective to reduce the amplitude, Sommerfeld effect and jump phenomenon of (NIS) while the linear (NES) not appropriate for the (NIS).
Keywords: Non-ideal structure, nonlinear energy sink, energy pumping.

Spatial Complexity of Two Dimensional Multi-layer Cellular Neural Networks

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This study investigates the complexity of the global set of output patterns for two-dimensional multi-layer cellular neural networks. Applying labeling to the output space produces a two-dimensional sofic shift space. The ordering matrices and symbolic transition matrices are introduced to study the spatial entropy of the output space.
Keywords: Cellular neural networks, Sofic shift, Spatial entropy.

Ball Motion with Rough Surfaces Impacts

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Some tasks about movement of a sphere on inertia are considered: between two parallel planes, inside sphere and inside the circular cylinder. It is considered that as a result of impact is satisfied condition roll without slicing – tangent speed of a contacting point Sphere is equal to zero. It is proved, that in all cases the movement in a limit leaves on the established mode On speed: the angular speed of a sphere aspires to constant values, and the speed of its centre becomes periodic, for sphere and cylinder. In some cases on the established mode leave and coordinate of position and orientation of a sphere.
Keywords: Nonlinear Mechanics, Nonlinear Dynamics, Asymtotic Methods, Friction, Rough Surfaces Impacts.

Reliability of Landslide Hazard Mapping Using Neural Networks in an Unstable Area of Sardinia (Italy)

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In this paper a methodology using neural networks (NN) for landslide hazard mapping is presented. The zone studied is located in the central-east part of Sardinia, Italy. It is characterized by several shallow and rotational landslide phenomena.
Neural networks represents a innovative methodology for landslide susceptibility zonation. Neural networks are analytic techniques modelled after learning processes similar to the neurological functions of the brain. A NN can be trained to identify certain patterns (e.g. landslides) and thus to predict the result for other data input.
Geomorphologic information as slope and aspects are calculated from Digital Elevation Models provided by Sardinian Regional Administration. Other parameters concerning lithology, land use and landslide location were evaluated from field surveys and from the literature. These data were used for neural network learning.
The comparison between the results obtained with the proposed methodology and those derived by heuristic techniques of landslide parameter overlay mapping shows a fair agreement.
Keywords: Neural networks, Landslide hazard, Ulassai Sardinia Italy

Rogue waves in laser with injected signal

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The appearance of rogue or freak waves, that are extremely large pulses, is well known in oceanographic and atmospheric sciences. Here we show that rogue waves appear also in a very simple optical system: a laser with injected signal. We show experimental evidence of rogue waves. We characterized them by measuring the amplitude probability distribution of the peaks and their probability distribution of occurrence. We compare different dynamical regimes identifying those for which freak waves are present and we determine the region in parameter space where it is more probable to observe them. Such region corresponds to a chaotic behavior indicating that rogue waves are generated by a deterministic process. Our experimental results are in good agreement with numerical simulations obtained from a model based on Maxwell-Bloch equations. We observe the appearance of freak waves whenever the parameter values are close to those corresponding to a saddle node bifurcation. Our results open the way to very simple experiments for studying the phenomenon of rogue waves in a large variety of systems. Finally we discuss the

connection of the statistics of rogue waves with that of the well known Levy Flights

Collective behaviors of congested transportation networks: Instabilities, Transient states, Congestion Spreading

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Analysis of traffic flow theory and modeling of vehicular congestion has mainly relied on fundamental laws, inspired from physics using analogies with fluid mechanics, many particles systems, etc. One main difference of physical systems and vehicular traffic is that humans make choices in terms of destinations, driving behavior and congestion information, which creates additional complexity to the system. While most of the traffic science theories mainly concern the classification of stationary states from free-flow and congested traffic states, empirical analysis of spatiotemporal congestion patterns has revealed additional complexity of traffic transient states and non-steady state conditions (see for example Munoz and Daganzo (2003); Helbing et al. (2009)). Thus, the known fundamental diagram (initially observed for a stretch of highway and provide a steady-state relationship between speed, density and flow) is not sufficient to describe the complexity of urban traffic systems and it is affected by significant experimental errors in the congested regime.
Recently, it was observed from empirical data in Downtown Yokohama (Geroliminis and Daganzo, 2008) that by aggregating the highly scattered plots of flow vs. density from localized measures, the scatter almost disappears and a well-defined Macroscopic Fundamental Diagram (MFD) exists between space-mean flow and density for a whole road network. But the understanding of the relation between the MFD and the microscopic dynamical properties of the system or the topological properties of the road network is still missing. We propose to face this problem by using a microscopic model for vehicle dynamics in a realistic road network which takes into account the intersections topology and realizes an individual mobility demand (Bazzani et al., 2007). By means of numerical simulations we analyze the system at different regimes to detect criticalities and phase transitions and to study the chaotic transient regimes in a congested situation.
This research has two main directions. On one hand we will investigate how the intersection topology (traffic signals, roundabouts) can affect the collective behavior of traffic networks as expressed by a MFD and the aggregated network dynamics. On the other hand, we will analyze the frequencies and propagation of flow breakdowns and congestion spreading processes in transportation networks.
The aim of the paper is to look for "generic" dynamical laws on how local congestion phenomena can grow and propagate at the network level and to point out the complex interrelationship between network topology, traffic demand and congestion dynamics.

Our goal is to give an interpretation to the experimental observations that urban traffic congestion may vary significantly even if the average mobility demands are similar.

Keywords: Traffic dynamics, transportation networks, congestion.

Sliding Mode Control with Boundary Layer For Chaotic Dynamical Systems

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The objective of this paper is to use Lyapunov based sliding mode control technique with a fixed and thin boundary layer in order to design chattering free control signals in the chaotic systems. Two nonlinear chaotic models are chosen to be the case study, Colpitts oscillator and Liu system. The simulation studies showed that this relatively simple control method is also effective to obtain the chattering free controlled signals without finite steady-state error in both chaotic models.

Keywords: Chaos Control, Colpitts Oscillator, Liu System, Sliding Mode Control, Boundary Layer

Is Octonionic Quantum Gravity relevant near the Planck Scale? – If Gravity Waves are generated by changes in the geometry of the early universe, how can we measure them?

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We ask if Octonionic quantum gravity is a relevant consideration near the Planck scale. Furthermore, we examine whether gravitational waves would be generated during the initial phase phi of the universe when triggered by changes in spacetime geometry; i.e. what role would an increase in degrees of freedom have in setting the conditions during, so that the result of these conditions can be observed and analyzed by a gravitational detector? The degrees of freedom argument referenced is modeled via a Gaussian chaotic mapping, with tie ins to thermal inputs into the universe.

Stable endogenous cycles in a non-Kaldorian IS-LM model with a negative interest elasticity of savings

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Using an explicit center manifold reduction in correspondence of a Bogdanov-Takens singularity, we are able to derive a simplified two-dimensional

framework to explore the global dynamics of the intermediate-run, IS-LM model of Schinasi's type, with pure money financing of the budget deficits. This system has long served as a prototype for the study of deterministic business cycle fluctuations arising in the neighbourhood of the steady-state. This literature, however, develops inside the so-called "Kaldorian tradition" which, starting from the S-shaped investment function, relies on a greater-than-unity marginal propensity to spend over the cycle. Our results, assuming a negative interest elasticity of savings, innovate the literature in what follows. First, for a set of parameter values close to the bifurcation levels, we find that two steady-states can emerge, one of saddle-type and one of non-saddle-type. Th! e non-saddle steady state fulfils standard Kaldorian assumptions, whereas the saddle steady-state does not require any assumption on the marginal propensity to spend over the cycle. Second, for a further specification of the parameter values, there exists a family of supercritical closed orbits, Hopf-bifurcating around the non-saddle steady state which are approached by either trajectories originating nearby the non-saddle steady state (the Kaldorian economy) or by trajectories originating nearby the saddle steady-state (the non-Kaldorian economy). This implies that the IS-LM model can lead to oscillating solutions even when the marginal propensity to spend is smaller than one.
Keywords: multiple steady-states; oscillating solutions, homoclinic orbits; Bogdanov-Takens theorem

On some p(x) - quasilinear problem in non variational case

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We consider a class of nonlinear elliptic equations containing a p(x)-Laplacian type operator, lower order terms having nonstandard growth. The model example is the equation

$$-\Delta_{p(x)}u + |u|^{p(x)-2}u = \mu$$

in a bounded set $\Omega \subset \mathbb{R}^N$, coupled with a Dirichlet boundary condition. For some right-hand side measure μ which admits some decomposition in $L^1(\Omega) + W^{-1,p'(x)}(\Omega)$

Keywords: Nonlinear elliptic equation, Sobolev spaces with variable exponent, entropy strongly-regular solution, truncations.

Experimental research of space distribution of the surface discharge glow structures inside the supersonic boundary layer

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Experiments on surface discharge glow registration were carried out on a shock tube in the supersonic and transonic gas flows with flow Mach numbers

up to 1.6 after the plane shock waves (Mach numbers up to 4). Other predetermined parameters include: air densities in the flow 0.02-0.30 kg/m^3, airflow velocities 600-900 m/s, time of discharge about 200 ns and the size of plasma sheet 10×3 cm^2. The short time of discharge enables the structure of the high-speed flow not to change during integral glow registration. The distribution of the plasma discharge radiation intensity corresponds to the instant distribution of gas density due to the strong dependence of radiation intensity on local value of reduced electric field *E/N*. Thus the images made could be considered as instant visualization of flow and it's peculiarities. This makes it possible to get spatial calibers typical for laminar and turbulent flow areas of boundary layer by relevant mathematical analysis of the spatial distribution of discharge glow. The spectrum of frequencies and amplitudes of discharge glow intensity in supersonic boundary layer are different for laminar and turbulent types of flow.

Images of the surface discharge glow could be considered as a 2D-plane system. Sliding-windows method was used for image processing and investigation of the fractal dimension. As a result, we have gotten the fractal dimension of the discharge glow in the image - it changes from 1,8 in the laminar boundary layer to 1.9 in the turbulent boundary layer.

Keywords: discharge glow, boundary layer, supersonic flow, laminar, turbulent, spatial calibers, fractal dimension.

Numerical Methods for Discontinuous Singularly Perturbed Differential Systems

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In this paper we study the numerical solution of singularly perturbed systems with a discontinuous right hand side. We will avoid to consider the associate reduced differential system because often this study leads to wrong conclusions. To handle either the stiffness, due to different scales, or the discontinuity of the vector field we will consider numerical method which are semi-implicit and of low order of accuracy.

Keywords: Singularly perturbed differential systems, Filippov discontinuous systems, numerical methods.

Dual Wavelet energy approach -regression analysis for exploring steel micro structural behavior

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Ultrasonic Ndt data are time series data decomposed in signal plus noise obtained from traveling ultrasonic waves inside a material and captured by piezoelectric sensors. The natural inhomogeneous and anisotropy character of steel made material causes high acoustic attenuation and scattering effect. This makes the data interpretation highly complex for Ndt operators. In this paper we

address the non linear features of back scattered ultrasonic waves from steel plates. The structural noise data captured from the specimens, and processed by an algorithm based on wavelet energetic approach, show significant insights into the relationship between backscattered noise and material microstructures. This algorithm along with correlation coefficients, residuals and interpolations calculations of processed ultrasonic data seems to be a well-adapted signal analysis tool for viewing material micro structural dimension scales. Experiments show interesting 3D interface and indicate a quasi linear signal energy distribution at micro structural level. It suggests probable incidence of microstructure acoustic signatures at different energy scales of the material phases. Finally multi polynomial interpolations of the processed noise data exhibit an attractor shape which involves chaos theory noise data modeling.

Simulation of Intracellular Processes

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This paper proposes a new computational framework for simulation of intracellular processes. The dynamics of the processes is implemented by introducing locally interacting agents that possess distinct inner structures. In this paper, the agents are represented by particles and their structures correspond to binary trees. Such approach allows encoding of any particle with finite alphabet symbol sequence. The framework being developed is focused on studying collective effects of particle interactions rather than on physical nature of an activity. Increasing individual particles interaction complexity allows reduction of effective number of particles required for a phenomena computation and as a result overall shorter computational time.
Keywords: intracellular processes, simmulation of intracellular reactions, collective behavior modeling, local interaction, Markov random fields, Gibbs measure, ergodic theory, ergodic decomposition.

Chaotic advection for participating medium rendering in computer graphics

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Chaos theory is frequently used in computer graphics research to depict natural phenomena. Indeed, both computer graphics and chaos theory aim at modeling natural complexity. We follow our previous ideas and works on how heterogeneous participating media can be modeled using chaotic map. We now focus on chaotic advection which rules the complex behaviour that a passive scalar, like density of a medium for example, can attain. We consider in this work flows, like the Arnold Beltrami Childress flows, that, even with simple dynamics, give rise to chaotic behaviour of Lagrangian particle trajectories. We use these trajectories to model and render a range of fluid behaviours like clouds evolution

or smoke and try to represent realistic details of these phenomena. Rendering is based either by imprinting fluid density along trajectories or simply using radial based function on each particle, using GPU. We will also do an exploratory research to evaluate if arbitrary fluid surfaces can be modeled or disrupted by these trajectories.

Keywords: Chaotic advection, computer graphics, participating medium, fluid dynamics

BetaBoop Brings in Chaos

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The Verhults differential equation $\frac{d}{dt}N(t)=rN(t)[1-N(t)]$ and its logistic parabola difference equation counterpart x_{t+1}=a x_t (1-x_t) $I_{(0,1)}(x_t)$, a□ [0,4] $, are tied to sustainable growth. We investigate the implications of considering 1-$N(t)$ the linear truncation of the MacLaurin expansion of -ln $N(t)$, or $N(t)$ the linear truncation of -ln(1-$N(t)$), i.e. of curbing down either the retroaction factor 1-$N(t)$ or the growing factor $N(t)$, which leads to Gumbel extreme value population for maxima or minima, respectively. More generally, we consider the differential equation $\frac{d}{dt}N(t)=rN(t)[-\ln N(t)]^{1+\gamma}$, or, alternatively, $\frac{d}{dt}N(t)=r[-\ln(1-N(t))]^{1+\gamma}[1-N(t)]$), and their difference equation counterparts, leading to the Fréchet and the Weibull extremal models for g>0 and g<0, respectively. Simple extensions of the beta densities arise naturally in this context, and we discuss a *BetaBoop*(*p,q,P,Q*), *p,q,P,Q*>0 family of probability density functions, that for *P*=*Q*=1 reduces to the usual *Beta*(*p,q*) family.

Keywords: Population dynamics and chaos, extremal models, beta family.

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Simulations of the Frequency Modulated - Atomic Force Microscope (FM-AFM) Nonlinear Control System

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The Frequency Modulated - Atomic Force Microscope (FM-AFM) is a powerful tool to perform surface investigation with true atomic resolution. The control system of the FM-AFM must keep constant both the frequency and amplitude of oscillation of the microcantilever during the scanning process of the sample.
However, tip and sample interaction forces cause modulations in the microcantilever motion. A Phase-Locked Loop (PLL) is used as a demodulator and to generate feedback signal to the FM-AFM control system. The PLL performance is vital to the FM-AFM performace since the image information is in the modulated microcantilever motion. Nevertheless, little attention is drawn to PLL performance in the FM-AFM literature. Here, the FM-AFM control system is simulated, comparing the performance for different PLL designs.
Keywords: Frequency Modulated Atomic Force Microscope, Phase-Locked Loops, Synchronization.

Spontaneous generation of solitons from steady state exact solutions to the higher order KdV equations on a half-line

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The Korteweg-de Vries (KdV) equation is a canonical equation which arises in many physical contexts as an equation governing weakly nonlinear long waves when nonlinearity and dispersion are in balance at leading order. If higher order nonlinear and dispersive effects are of interest, then the asymptotic expansion can be extended to the next order in the wave amplitude which leads to the higher order KdV equations.
The analysis of initial-boundary value (IBV) problems for nonlinear evolution equations on the positive half-line $0 < x < \infty$ or on the negative half-line $-\infty < x < 0$ has received considerable attention over recent years (they are usually referred to as the IBV problems on the positive or negative quarter plane since it is assumed $t > 0$). In particular, the IBV problems for the Korteweg-de Vries equation on a quarter plane has been considered by a number of authors and a review of some of the more significant literature in the area can be found in [1], [2]. These types of problems arise naturally as a model whenever waves determined at an entry point propagate into a patch of a medium for which disturbances are governed approximately by the KdV equation. Formulation of the IBV problem for the KdV equation for a variable $u(x, t)$ in a quarter plane includes setting an initial distribution of the variable $u(x\ 0)$ = ui(x) and a boundary

condition $u(0; t) = ub(t)$. (Below we will consider, for definiteness, only the IBV problem in a positive quarter-plane, for the IBV problem in a negative quarter-plane two boundary conditions are required.) A common feature of all the problems considered in the literature is that the boundary value of the variable changes with time so that the travelling wave solutions (solitons) are generated by the boundary forcing. A natural example arises when modeling the effect in a channel of a wave maker mounted at one end. In many studies, the boundary value $ub(t)$ is taken to be a constant for $t > 0$, which is a physically meaningful condition for a number of applications, such that *ub* differs from ui(0), and thus a jump of the variable at the boundary occurring at the initial moment plays a role of boundary forcing.

The problem considred in the present study differs conceptually from all those. The IBV problem for the higher order KdV equation for a variable $u(x; t)$ is considered on a half line with a boundary condition $u(0; t) = ub$ where *ub* is *constant for any t*. The initial *Spontaneous generation of solitons* 2 distribution is taken to be the steady state solution of the equation for that boundary condition. In such a situation, it is expected that, in the absence of perturbations, this steady state distribution should remain unchanged for an infinitely long time. And it does remain unchanged but only till some moment. At this (indefinite) moment, the distribution spontaneously starts to change (but the same constant value of the variable is maintained at the boundary) such that a soliton is generated near the boundary. This soliton propagates from the boundary and when it is far from the boundary it becomes practically undistinguishable from the single soliton solution of the governing equation.

The only difference of the corresponding distribution of the variable from the single soliton solution is that at every moment the distribution adheres to *ub* at $x = 0$. Thus, solitons are spontaneously generated on a background of the steady state distribution – no boundary forcing, no perturbations, no noise or other random forcing. This picture is based on the *exact explicit* solutions of the governing equation. Of course, the solution itself is deterministic and the time moment, at which the steady state distribution is spontaneously broken to generate a soliton, is determined by the parameters imbedded in the solution. Those parameters *are not present in the problem formulation* and so can be considered as “hidden parameters”. It is worth noting here that the steady state background distribution is also a solution of the governing equation so that a variant when no solitons are generated is also possible. Thus, an obser4ver looking at the steady state cannot know when a soliton will be generated and whether it will be generated at all,

The solutions have been obtained by applying a direct method designed specifically for constructing solitary wave solutions of evolution equations [3]. The solutions represent combinations of hyperbolic and algebraic functions. Such solutions cannot be obtained by applying the popular ”tanh”, ”sinh” and so on methods.

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Modelling & Prediction of Performance Characteristics of an Air Launched High Speed Supercavitating Vehicle

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Supercavitation is an emerging technology in which the most cursed 'Cavitation' is used as a beneficial to engineering application. Supercavitation is achieved when a body moves through water at sufficiently high speed, so that the fluid pressure drops to the water vapour pressure and a vapour bubble (called cavity [1]) envelops the entire vehicle (except the cavitator and fins). Hence, the skin friction drag of the vehicle becomes almost zero. Hence, vehicle can move in the two phase medium.

The development of supercavitating vehicle has been confronted with various challenging problems such as the potential instability of the vehicle, the unsteady nature of the cavity dynamics and the complex, non-linear and time delayed nature of the interaction between vehicle and cavity. Moreover depending upon some non dimensional parameter e.g. cavitation number (σ), the equilibrium of the vehicle may shift from a stable equilibrium to a limit cycle [2]. Various approximate models for the dynamics of the cavity based on the potential flow theory and various experiments are well documented and given in [3].

In this study, 6-dof equations of motion are developed at the vehicle nose to incorporate the movement of C.G. of the vehicle due to burning of fuel and change of mass and moment of inertia of the vehicle (given below in vector form).

$$m\dot{V} + \dot{\Omega} \times (mr_g) = F - \dot{m}(V + V_g) - \Omega \times (mV) - 2\Omega \times (mV_g) - m\dot{V}_g - \Omega \times (\dot{m}r_g) - \Omega \times (\Omega \times (mr_g))$$

…… (1)

$$I\dot{\Omega} + (mr_g) \times \dot{V} = M - \Omega \times (I * \Omega) - \dot{I} * \Omega - (mV_g) \times V - (mr_g) \times \dot{V}_g - \Omega((mr_g) \times (V_g + V)) - (\dot{m}r_g) \times (V_g + V) - (V_g + V) \times (\Omega \times (mr_g))$$

……(2)

where, V and Ω are the translation velocity and angular velocity vector. rg = position vector of C.G. Vg = velocity of C.G. in body axes and the other symbols have their usual meaning.

The vehicle is launched from an aircraft to attain the sufficient velocity at impact on water to form the cavity around the vehicle. For the shape and dynamics of cavity (unsteady), Logvinovich cavity model [4] is used with the principle of Independence of the cavity sections expansion [4], shown in fig: 1. and the effect of deflection of cavitator and gravity in the shape of cavity is considered. The dynamics of cavity is coupled with the vehicle dynamics with memory effect and time delay and their interaction produce Planing force [8] which is a dead-zone kind of force. Depending on angle of attack fins also interact with the cavity boundaries making different small cavities (termed as base cavity, partial cavity and supercavity) and hence fin forces are too nonlinear. Nonlinear fin forces and

moments are calculated using CFD and well tabulated in [5] are used for the dynamics simulation.

First, simulation of the complete air trajectory [6] of the vehicle is done. Then water entry (using logvinovich's Principle [4]) and underwater trajectory of supercavitating vehicle is simulated considering the effect of change in mass of the body due to burning of the fuel and its performance characteristics are predicted.

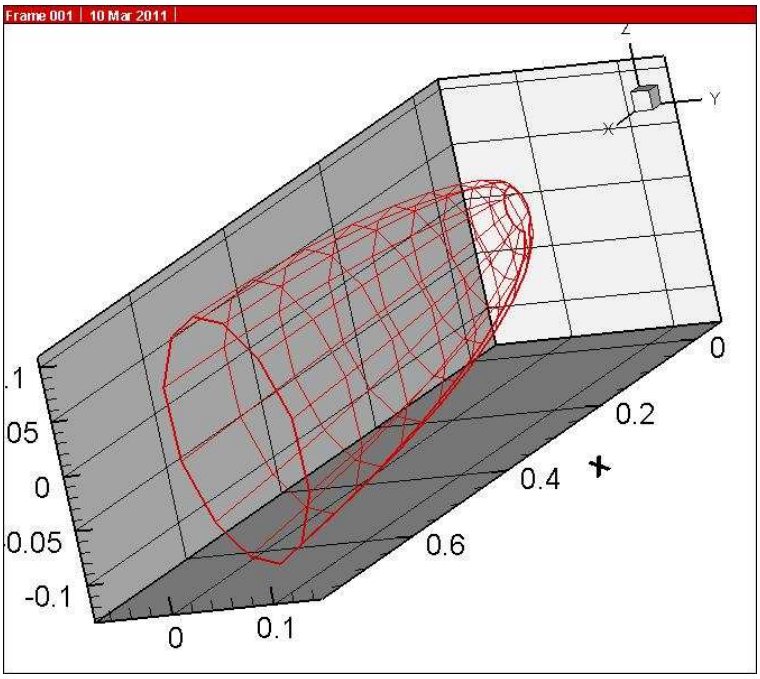

Fig: 1, Shape of the cavity at 30^0 angle of cavitator, 150 m/s vehicle speed and at 10 m depth,
cavitation no. (σ) = 0.0171.

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Dumb-Bell of Variable Length in an Elliptic Orbit: Relative Equilibria, Periodicity, and Chaos

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Planar motion of an orbiting dumb-bell having a variable length in a central field of gravity is under analysis. Within the so-called "satellite approximation" planar attitude dynamics is described by a non-autonomous equation of the second order. The rule of the dumb-bell length vibrations implying an existence of the radial and tangent relative equilibria for any value of the orbit eccentricity is proposed. Stability of the found relativer equilibria and chaoticity for total dynamics are investigated.
Splitting of separatrices for the perturbed, with respect to the pendulum-like motions, problem is established. This effect was proved not only for small eccentricities, but also for their finite values. Moreover, it turned out that the chaotic dynamics of a dumb-bell with an invariable mass distribution, existing because of the ellipticity of the orbit, cannot be suppressed with aid of periodic variations of the mass distribution, or the dumb-bell length.
Nevertheless one might observe islands of regularity corresponding to librations of large amplitude demonstrating stable behavior. These librations can be useful for the transportation operation in the near-transversal directions of the dumb-bell orbital motion.
Keywords: dumb-bell, elliptic orbit, controlled motion, attitude dynamics, splitting of separatrices, chaoticity, islands of regularity

Deterministic coherence resonance in systems with on-off intermittency and delayed feedback

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Coherence resonance consists in the increase of regularity of an output signal of a nonlinear device for non-zero intensity of input noise. This phenomenon occurs, e.g., in stochastic systems with delayed feedback in which external noise amplifies the periodic component of the output signal with the period equal to the delay time. In this contribution it is shown that in chaotic systems with delayed feedback deterministic (noise-free) coherence resonance can occur, which consists in the maximization of the periodic component of the output signal in the absence of stochastic noise, due to the changes in the internal chaotic dynamics of the system as the control parameter is varied. This phenomenon is observed

in systems with on-off intermittency and attractor bubbling, including generic maps and systems of diffusively coupled chaotic oscillators at the edge of synchronization. The occurrence of deterministic coherence resonance for the optimum value of the control parameter (e.g., of the coupling strength between synchronized oscillators) is characterized by the appearance of a series of maxima at the multiples of the delay time in the probability distribution of the laminar phase lengths, superimposed on the power-law trend typical of on-off intermittency, and by the presence of a strong maximum in the power spectrum density of the output signal.

Keywords: coherence resonance, on-off intermittency, synchronization

Building Multi-dimensional Chaotic Functions for Real-time Encryption of Multimedia Streams

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With the proliferation of video streaming applications, the need for multimedia encryption techniques is becoming of utmost importance.
On the opposite to traditional encryption algorithms, multimedia ciphers should adapt to the real-time constraints as well as the variable bit rate characterizing modern communication technologies.
This paper presents a technique to generate chaotic functions allowing real-time encryption of multimedia streams. The proposed approach unifies the compression and encryption functionalities using the wavelet transform and chaotic functions to build up random permutations. The major advantage of our chaotic multimedia encryption process is that a client can access to multiple resolutions of the streamed video. These resolutions vary according to the security level of the client as well as the networking and processing capabilities. A set of simulations have also been carried out to assess the performance of the proposed coding scheme in terms of security, compression ratio, and error resilience.

Toroidal electromagnetic waves

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Electromagnetic waves with toroidal symmetry are considered. The problem with boundary conditions on the singular ring of the toroidal coordinate system is investigated. The boundary conditions are taken taking into account the conformity between the toroidal and cylindrical waves [1] on the ring.
In this case the singular ring looks like convolute axis of cylindrical system.
The appropriate system of wave modes are obtained as Maxwell equation solutions in an integral form with source function. Clifford number representation of Maxwell equations [2] and the appropriate source function [3] are used.

Keywords: Electromagnetic waves, Toroidal symmetry.

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Quantum-Classical Correspondence through Entanglement Dynamics

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Quantum entanglement is an important resource in quantum information processing. The capability of preparing quantum states that are highly entangled is especially significant in applications such as quantum teleportation and superdense coding [1]. An approach to prepare such states is to examine the time evolution of quantum states generated by Hamiltonians of two-coupled oscillator systems. In this talk, I will present our recent investigation on the dynamics of entangled states which are generated by systems that are classically regular, mixed, and chaotic [2-3]. For systems that are classically regular, we found periodic entanglement which has twice the frequency of the corresponding classical motion. Such frequency doubling continues to hold true in the entanglement dynamics for a second model that exhibits a two-frequency orbit in the classical domain. Surprisingly, we found that a periodic classical trajectory can give rise to a quasi-periodic entanglement dynamics upon quantization. For a system that is chaotic, we have reaffirmed existing results that the entanglement production rate is higher when the classical system is more chaotic, i.e., the system possesses a more positive Lyapunov exponent [4]. When the system contains a mixed phase space, the entanglement dynamics is found to be insensitive to the choice of the initial conditions in the regular or the chaotic classical regime. In fact, we have demonstrated complete dependence of the dynamical pattern of entanglement on the global classical dynamical domain without being influenced by the local classical behavior in all the three classical regimes for the first time. While such global dependence is not necessary for all coupled oscillator systems, the “nonlocal” models that we have investigated have the advantage of generating an encoding subspace [5] that is stable against any errors in the preparation of the initial separable coherent states. Such a feature will be physically s ignificant in the design of robust quantum information processing protocols.

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The Financial Instability Hypothesis: a Stochastic Microfoundation Framework

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This paper examines the dynamics of financial distress and in particular the mechanism of transmission of shocks from the financial sector to the real economy. The analysis is performed by representing the linkages between microeconomic financial variables and the aggregate performance of the economy by means of a microfounded model with firms that have heterogeneous capital structures. The model is solved both numerically and analytically, by means of a stochastic approximation that is able to replicate quite well the numerical solution. These methodologies, by overcoming the restrictions imposed by the traditional microfounded approach, enable us to provide some insights into the stabilization policies which may be effective in a financially fragile system.
Keywords: Financial fragility, complex dynamics, stochastic aggregation.

Data assimilation with Artificial Neural Networks and SPEEDY AGCM: First Results

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Weather forecasting systems require a model for the time evolution and an estimate of the current state of the system. The numerical weather prediction (NWP) incorporates the equations of atmospheric dynamics with physical process and it can predict the future state of the atmosphere.Data assimilation provides such an initial estimate of the atmosphere where it combines information from observations and from a prior short-term forecast producing an current state estimate. This work investigated the approache of data assimilation with Artificial Neural Networks (ANN). The short-term predictions are from a global primitive equation model, the SPEEDY model *Simplified parameterizations, primitive-Equation Dynamics*, simplified physical processes of an atmospheric general circulation with resolution in tridimensional coordinates.

The SPEEDY model has similar characteristics to the state-of-art atmospheric models. For the data assimilation scheme, it applied a supervised ANN Multilayer Perceptron to emulate the analysis results for Local Ensemble Transform Kalman Filter (LETKF). LETKF is an approximation of Kalman filter, with Monte-Carlo ensemble of short-term forecasts to estimate the forecast model error covariances. The method using RNA in this work can be described as a process of data assimilation, where the ANN trained after obtaining the results, like a function of the state model SPEEDY and its synthetic observations. The ANN supervised was trained with 1982 to 1984 data, and the data assimilation cycle have been run together SPEEDY model and the synthetic observations to January, 1985. The numerical results demonstrate the effectiveness of this ANN technique in atmospheric data assimilation because these have been very close to the results compared with LETKF data assimilation results. The simulations demonstrate the great advantage in using neural networks: the best computational performance.
The main emphasis of this technique is the computational speed in obtaining the initial condition for state model that accelerates the whole process of numerical weather prediction.

Dynamics of the Reaction Glucose - Catalase – Glucose Oxidase - Hydrogen Peroxide

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Glucose – catalase – glucose oxidase – hydrogen peroxide reaction is one of the few known enzymatic systems studied *in vitro* in the field of nonlinear chemical dynamics. This reaction belongs to the family of oscillatory enzymatic reactions, which form a natural basis of oscillations in biological systems. The experimental setup consists of two separate cells connected via a dialysis membrane. The first cell contains hydrogen peroxide which permeates through the membrane to the second cell. The second cell contains catalase, which catalyzes production of oxygen, and glucose oxidase, which catalyzes oxygen consumption. The time variation of dissolved oxygen concentration of the reaction solution in the second cell is measured by an inserted polarographic or optical oxygen probe. A parametric study of dependence on mixing, temperature and initial concentrations of components in a in a batch and continuous-flow stirred tank reactors was carried out. A proposed mathematical model of the reaction agrees with the obtained experimental data; hence it is useful for finding initial conditions where the course of dissolved oxygen shows nonlinear behavior such as periodic oscillations. Subsequent modeling and experimental study include periodic perturbations by hydrogen peroxide and enzyme or glucose solutions. The response on periodic perturbations involves phase-locking and chaotic oscillations.
Keywords: enzymatic oscillatory reaction, catalase, glucose oxidase.

The Timoshenko Model in Atomic Force Microscopy

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The Atomic Force Microscope is versatile instrument that has been applied to a large number of research topics, including nanomachining. Its commercial use involves contact and noncontact modes of operation. The dynamic response of the AFM cantilever has been investigated through analytical and numerical models.
Here we shall consider the nonlinear beam Timoshenko model subject to an axial force. The interaction tip-sample force enters as a boundary condition or as a concentrated force at the end of the tip attached to the free end of the microcantilever.
This approach will allow todiscuss in a unified manner different types of AFM's, including nonlinearities in geometry and physics. Eigenanalysis is done in terms of a fundamental matrix response of a second-order damped matrix differential equation, subject to boundary conditions. It is shown that there is a completely oscillatory behaviour of the fundamental response when the frequency is above a critical value. The Galerkin method is used to derive reduced-order models as systems of second-order differential equations for the forced response which can be discussed with analytical or numerical simulations for involved nonlinear phenomena.
Keywords: Atomic force microscopy, Timoshenko beam, eigenanalysis, Galerkin method.

Linear Least Squares Estimate of Noise Level in Chaotic Time Series via L-infinity Norm Correlation Sum

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In this work we propose a linear least squares method to estimate the noise level in chaotic time series. For this purpose we give a non iterative algorithm based on the functional form obtained by Schreiber in 1993 where the effects of noise on L-infinity norm correlation sums can be quantified via the nonlinear functional. The asymptotic expansion of the functional has shown that, a slightly modified version of the functional leads to a linear approach that gives satisfactory results for simulated continuous flow data even for high level of noise contributions up to 80%. We also discuss the efficiency of the method on map

and flow data where we give real world examples for financial and biomedical time series.

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Morphogenesis and Synchronization of Complex Interaction Networks Dynamics

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The aim of this paper present two ways of considering interaction networks, taking into account the nature of complexity at different stages of the system life-cycle : from its genesis to its evolution. Therefore, some structural aspects of the complexity dynamics are highlighted, leading (i) to implement the morphogen-esis of emergent complex network structures, and (ii) to observe and study some synchronization phenomena within complex networks. Specific applications are proposed to illustrate these two aspects, in urban dynamics and in neural networks.

In the first one, bio-inspired mecanisms are used to model complex system morphogenesis. The context of the proposed model concerns the integration of spatial constraints within the system formation, as a catalyst of the formation itself. A case study is developed on urban dynamics, involving users-services mecanisms as a two-way interaction system: (i) attraction mecanism of services on users and (ii) adaptive evolution of services under the inuence of emerging organization of users.

In the second one, after presenting the Hindmarsh-Rose neuronal model and the main aspects of a single model dynamics, we focus on two synchronization phenomena within networks composed of Hindmarsh-Rose models. For different topologies of networks, the coupling strength to obtain complete synchronization is studied and this gives rise to a classical power law according to the number of neuron in the network. The burst synchronization phenomenon is finally studied. Different neurons are in burst synchronization motion if they fire the same number of bursts all starting at the same moment. The detection of this kind of synchronization requires the development of a

specific algorithm which is presented in the last part of this work. This algorithm applied to different kinds of network topologies gives encouraging results, such as the fact that the coupling strength to observe burst synchronization within networks depends on he diameter of this network.

On both of the two stages presented here based on two differents applications, we focus on the control of the system, preserving its complexity. In the first stage, concerning system genesis, the control is expressed at the top level of description -that is on the system formation - while the low-level of description - that is the entities themselves - is freely evolving. In the second stage, concerning the evolution of an existing system, the control is expressed through the management of coupling parameters, making dynamical system network able to synchronize its compoments.

Keywords: Complex Systems, Interaction Networks, Topology, Nonlinear Dynamics Networks, Morphogenesis, Synchronization.

Chaotic behaviour induced by modulated illumination in the Lengyel-Epstein model under Turing conditions

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The photosensitive CDIMA reaction was investigated using the Lengyel Epstein model modified to include the effect of external illumination. Different spatial patterns are exhibited under constant values of light, ranging from Turing Spots to Stripes for the minimum and maximum values of illumination, respectively. Moreover, by neglecting the diffusion, the system displays oscillations with a characteristic period that also depends on the illumination value. When illumination is set to periodically oscillate three different behaviors are observed. Namely, a regime exhibiting the period of the external forcing; another where there is a resonance between several periods of oscillations and a broad regime where the system demonstrates a chaotic-like behavior.

Keywords: Chaotic modeling, Lengyel-Epstein model, CDIMA phtosensitive reaction, reaction-diffusion system.

Critical manifold of an oscillatory reaction model with more than one fast variable

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Recently, a mechanism of three and more dimensional dynamical systems with mixed mode oscillations and chaos, based on slow-fast dynamics

and canard solutions on critical manifolds has been proposed. Critical manifolds of mixed mode oscillations are explored here by means of numerical simulations of the Bray-Liebhafsky oscillatory reaction in continuously fed well stirred tank reactor. Small amplitude oscillations obtained as a part of mixed mode dynamics appear around the fold curve and slow nullcline. We discuss possibilities that small amplitude oscillations obtained as a part of mixed mode dynamics are governed by folded node, singular Andronov-Hopf bifurcation or dynamic Andronov-Hopf bifurcation.
Keywords: oscillatory reaction, mixed mode oscillations, critical manifold, multiple time scale, Bray-Liebhafsky oscillatory system

Experimental Observation of Shilnikov Chaos and Mixed mode oscillations in Electronic Circuit

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Shilnikov chaos is revealed in single Chua and two coupled Chua circuit. Basically an assymmetry is induced in Chua circuit to control different regimes of mixed-mode oscillations as a route of transition to Shilnikov chaos. Detail experimental evidences are presented

The Chaotic Analysis of Financial Time Series: Classification of Foreign Exchange Rates Series via Their Exponential Divergence Curves

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In this work we evaluate the notable results of four interrelated successive works dealing with the classification properties and temporal evolution of foreign exchange rates series (ForEX). The main idea in these works can be conceptualized through the behavior of the exponential divergence curves of financial time series that make a clear distinction for both spatial (between countries) and temporal (between different time segments of ForEX series) patterns. Despite being a well known concept since the work of Gao and Zheng (1994), the use of exponential divergence curves for the classification of ForEX series is a relatively new concept. The classification procedure discussed by Das and Das (2007) is based on the surrogate testing procedure where the statistics gathered from the original system is compared to the ones that are gathered from a completely randomized system. Our new researches on the data durin! g the period of present economic recession (January 208-October 2009) by calculating the largest Lyapunov exponent (LLE) has shown that the earlier classification of countries based on LLE's holds true . By a similar

approach, we have investigated the temporal evolution of the exponential divergence distance metrics based on the work of Celluci et. al (1997) where we have developed a computationally consistent procedure to obtain the distance metrics for various ForEX series. Finally we obtained strong indicators for the distinction of the temporal evolution of ForEX series for developed and developing countries. We discuss possible reasons for the existing separation of temporal structures.

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Special Types Of Particles-Optics Of A Raindrop

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Fog, rain, mist, and haze are a few examples of scattering media consisting of small spherical particles. The particles are water drops. Water has a refractive index ranging in the visual region from m=1.330(red,λ=0.7μ)to m=1.432(violet, λ=0.4μ). This is why so many computations have been made that refer to the particular values m=1.33, or m=4/3.

Anomalous Diffraction by Water Drops Mecke(1920) was the first to call attention to the fact that there is a range of drop sizes for which the refracted and reflected light in the directions around θ=0 and the diffracted light amplitudes of comparable magnitude. He also suggested that the interference of these three components would give rise to the effects of anomalous diffraction. Since then, a precise discussion of this problem has been given in the limit of m near 1. When Mecke first did this, he made a phase error in neglecting the change of phase at the passage of a focus. Later computations on the same principle but with correct phases were made by Bricard(1946) and by Ljunggren(1949). Bricard starts his paper with the simple addition of intensities, but in later sections he also computes the phases and adds the three components with nthe proper phases without considering the two polarizations separately. Ljunggren has been more ambitious and has not, a priori, been content withapproximations that may obtained from geometrical optics. But after a number of manipulations with the

Mie's formulae the refracted component appears to come the precisely this approximation again with the correct phase.
Particles-Optics-Raindrop-Anomalous Diffraction

Multifractal analysis of the psychorelaxation efficiency for the healthy and pathological human brain

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Changes in EEG time series before, during and after removing a pain syndrome by applying the psychorelaxation technique are examined for healthy subjects and patients with chronic somatoform pain disorders connected with disruptions of interrelations between cortex and subcortex on the thalamic and the brain-stem level. The degree of psychorelaxation and decrease of the pain syndromes is estimated as a change in the multifractality degree gained by the wavelet transform modulus maxima method.
For the healthy subjects we observe the reliable decrease of the multifractality degree and the enhancement of the anticorrelated dynamics of consecutive EEG values during the pain and their recovery up to previous values during psychorelaxation. The all healthy subjects notice that the pain syndrome disappears. The analogous dynamics in the multifractality and the improvement of the functional state are observed only for 70% “thalamic”patients. For other 30% patients of the group the multifractality degree remains less than for the healthy subjects. For all the “brain-stem”patients during relaxation the multifractality degree remains high and the singularity spectrum corresponds to both the correlated and anticorrelated dynamics. The study demonstrates that the changes in the multifractality give a good ability to estimate the psychorelaxation efficiency for the healthy and pathological human brain
Keywords: EEG, psychorelaxation technique, multifractal analysis.

Nonlinearities in Dynamic Model of Small Wind Power Generator

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Nonlinear dynamic system is considered that models a small-scale wind generator connected with external electric power consumers. Nonlinearities in this model are due, on the one hand, to the aerodynamic load upon wind turbine blades, and, on the other hand, to the reactance of the electric power generator. Influence these nonlinearities upon steady solutions and their stability is studied.

Detection and Characterization of Cracks in Beams via Chaotic Excitation and Statistical Analysis

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Vibration-based damage detection methods are widely used to identify hidden damages in beam and structural components. Commonly, the structure is made to vibrate to extract some quantitative features that increase or decrease based on the crack depth. For example, numerous experimental and simulation studies analyze variations in natural frequency of the structure to detect crack depth. Unfortunately, the ability to effectively characterize crack depth in this manner is limited by the very small variation in the natural frequency resulting from the change in crack depth. Harmonic excitation is the most common method used in vibration-based crack detection studies.

In recent years, many researchers have investigated the use of chaotic excitation signals to develop vibration-based crack detection techniques due to their applicability over a wide frequency spectrum. Although the influence of chaotic excitation on statistics-based characterizing parameters has been investigated, the results are not very satisfactory. In fact, statistics-based characterizing parameters are significantly influenced by the choice of chaotic signal used for excitation. Using a harmonic signal to excite a plate structure in the vicinity of its natural frequency, statistics-based characterizing parameters have been shown to yield satisfactory results in predicting the severity and location of crack.

In this paper, we consider the chaotic signal of Duffing's oscillator to excite a beam and analyze statistical properties of the resulting time series of beam response to detect and characterize the crack. We begin by using a single degree of freedom (SDOF) approximation of a cracked beam excited by a chaotic input. We analyze the time series of the response to establish that salient statistical parameters, e.g., standard deviation, skewness, and kurtosis are strongly influenced by crack properties and can be used to quantify the crack. Moreover, we extend this framework to the continuous model of structure to predict not only the extent of crack but also its location along the beam. Specifically, using a finite element model of a cracked cantilever beam, spatio-temporal responses are produced with chaotic displacement at beam support and different crack characteristics. An extensive numerical study reveals that, as in the case of SDOF model, standard deviation and kurtosis of response data can yield information about the location and severity of crack. In contrast to prior research, our proposed technique does not necessitate the reconstruction of the chaotic attractor; instead all relevant information is extracted directly from the time series of vibration response. We present several alternatives to allow the detection of i) only the presence of crack using one time series data; ii) the location and severity of crack using time series data measured at uniformly distributed locations along the beam span; and iii) approximate location and severity of crack using only two time series data. Finally, we provide results of an experimental study which systematically collects responses corresponding to the SDOF approximation of the cantilever beam with a crack of varying depth at a fixed location. This experimental study validates that statistical parameters such as standard deviation, skewness, and kurtosis can accurately predict crack severity.

Wave Fractal Dimension as a Tool for Detecting Cracks in Beam Structures

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Vibration-based methods for crack detection in beam type structures continue to attract intense attention from researchers. Most often these methods use external forcing input to cause the structure to vibrate. Due to its simplicity and ease of implementation, harmonic forcing input is widely used. Several researchers have also used combinations of harmonic inputs, wherein more than one harmonic input is applied simultaneously to the beam at different locations along its span. Typical vibration-based crack detection methods exploit modal analysis techniques to determine changes in beam's natural frequency and relate these changes to the crack severity and in some cases to crack location.

To quantify the crack depth and to detect crack location, vibration-based crack detection methods employ a variety of characterizing parameters, such as natural frequency, mode shape, mechanical impedance, frequency response functions, statistical parameters, etc. In recent research, wave fractal dimension, originally introduced to characterize biological signals, has been used to detect the severity and location of crack in beam and plate structures. Specifically, wave fractal dimension has been used for crack detection by considering one and two modes of vibration of a beam.

Since the start of this decade, progress in chaos theory has led several researchers to consider the use of chaotic excitation in vibration-based crack detection. A majority of these efforts necessitate the reconstruction of a chaotic attractor from the time series data corresponding to the vibration response of the structure. To detect and characterize cracks, the current chaos-based crack detection methods use a variety of chaos and statistics-based parameters, such as correlation dimension, Hausdorff distance, average local attractor variance ratio, etc.

In this paper, we study the use of wave fractal dimension as a characterizing parameter to predict the severity and location of a crack in a beam that is made to vibrate using a chaotic input. Specifically, wave fractal dimension of the time series of beam response and its corresponding power spectrum is studied to develop a new crack detection methodology. We begin by analyzing the single degree of freedom (SDOF) approximation of a cracked beam that is made to vibrate using non-zero initial condition, harmonic excitation, and chaotic excitation. Both time and frequency domain results illustrate that the wave fractal dimension analysis is able to consistently and accurately predict crack severity under chaotic excitation using Chen's oscillator. Next, a finite element simulation of the cracked cantilever beam with chaotic excitation is used to produce spatio-temporal responses for different crack depths and locations. The resulting simulation data is analyzed using wave fractal dimension in frequency domain and reveals distinctive variation vis-à-vis crack location and severity. Finally, we provide results of an experimental study which systematically collects responses corresponding to the SDOF approximation of the cantilever beam with a crack of

varying depth at a fixed location. This experimental study validates that the wave fractal dimension can accurately predict crack severity.

Modeling of Baltic Sea ecosystem using POP model

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A 3D ecosystem model of Baltic Sea is presented, and model output is compared with field data from the southern Baltic Sea. This model is used to estimate the annual phytoplankton biomass under circulation and solar radiation forcing conditions. The marine ecosystem model consists of a set of equations. There are all of the same general form, i.e. equations of the diffusion type (a second-order partial differential equation), expressing changes in any state variable. The marine ecosystem model is coupled to the three-dimensional, time-dependent hydrodynamical model, POPCICE for the Baltic Sea. The POPCICE model consists of Parallel Ocean Program (POP) and Community Ice CodE (CICE). Both models are from Los Alamos National Laboratory (LANL). POPCICE was forced using European Centre for Medium-Range Weather Forecasts (ECMWF) data. The POPCICE model provides the velocities, temperature and salinity on a temporal and spatial scale that resolves the atmospherically induced variability mentioned above. The results of the simulations are presented for one year (2004) for the whole of Baltic Sea. Model generally in good agreement with field data. The study was financially supported by the Polish State Committee of Scientific Research (grants: No N N305 111636, N N306 353239) and ECOOP IP WP 10.1.3 Project.
Keywords: 3D ecosystem model, Baltic Sea, phytoplankton, nutrient, temperature

A New Solution for Optimal Control a Non-Linear Model by Transformation to Measure Space

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In the recent decade, a considerable number of optimal control problems have been solved successfully based on the properties of the measures. Even the method, has many useful benefits, in general, it is not able to determine the optimal trajectory and control at the same time; moreover, it rarely uses the advantages of the classical solutions of the involved systems. In this article, we are going to use of measure theory for solving bone marrow cancer. Model adapted from a paper by K.R.Fister and J.C.Panetta [9].
Keywords: Non-Linear Model, Bone marrow cancer model, optimal control, Radon measure, cell-cycle-specific, dynamic System.

Robustness To Frequency Attacks Of A Chaos Based Spread Spectrum Watermarking Algorithm

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This paper presents a blind spread spectrum watermarking algorithm in discret cosine transform (DCT) domain based on chaotic sequence features for still image. We used logistic map with two secret keys; one to generate a spread spectrum sequence and other to determinate the secret insertion positions of the mark; the insertion of the mark was done in the middle frequency of DCT of the image to be watermarked. This allowed to have a compromise between invisibility and robustness against frequency attacks (JPEG compression, Median filter, gaussian filter...).
Keywords: Watermark, spread spectrum, Chaos, Attacks.

Dynamical Transport Barriers

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The non-twist standard map occurs frequently in many fields of science specially in modeling the dynamics of the magnetic field lines in tokamaks. Robust tori, dynamical barriers that impede the radial transport among different regions of the phase space, are introduced in the non-twist standard map in a conservative fashion. The resulting Non-Twist Standard Map with Robust Tori (NTRT) is an improved model to study transport barriers in plasmas confined in tokamaks. The robust torus prevents the magnetic field lines to reach the tokamak wall and reduces, in its vicinity, the destruction of islands and invariant curves due to the action of resonant perturbations. Our results indicate that the RT implementation would decrease the field line transport at the tokamak plasma edge

Synchronization of two semiconductor ring lasers working in chaotic regime: Applications to chaos-based optical communications

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Synchronization of two uni-directionally coupled semiconductor ring lasers working in chaotic regime (transmitter and receiver) is presented. Two

different configurations: open and closed loops are investigated as well as two different ways of light injection: one- or two-mode injection. We show that the closed loop configuration is more efficient for synchronization than the open loop. When one directional mode is injected very high coupling between the lasers is required to get the lasers synchronized while in case of injection of both modes synchronization with cross-correlation coefficient of 0.999 can be obtained at moderate values of coupling. ON/OFF phase shift keying method is successfully applied to encrypt the message at high bitrates.

Keywords: Semiconductor ring laser, Optical feedback, Synchronization, ON/OFF phase shift keying

Multiple Equilibria, Binges, and Chaos in Rational Addiction Models

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Addictions play a role of increasing importance in our time. People become addicted to alcohol, nicotine, drugs, eating, television, work and many other activities. At a first look addictive behaviour seems to be the result of irrationality. A rational decision maker maximizes the discounted utility stream over an infinite time horizon subject to a budget which can be replenished by habit-dependent earnings. Addiction to the good requires that past consumption increases the marginal utility of current consumption. Becker and Murphy (1988) have established the existence of unstable steady states leading to tipping behavior for optimal consumption rates.

In the first part of this talk a simple linear-quadratic optimal control model is used to illustrate how their approach fits into the framework of multiple equilibria and Skiba points. By changing the degree of addicition and the level of harmfulness we obtain a variety of behavioral patterns including 'cold turkey'.

In the second part it is shown that strong complementarity might imply persistent oscillations in the optimal consumption pattern. Using Hopf bifurcation theory, we prove the existence of stable limit cycles.

Finally, we will show how chaotic consumption patterns may evolve in a discrete, two-state behavioral addiction model. The occurence of chaos is proven by locating a horseshoe in the phase space.

State Estimation And Control Of The Rigid-Flexible Nonlinear Robotic Manipulator

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This paper investigates the position and vibration control of a nonlinear rigid-flexible two link robotic manipulator. The nonlinear control technique used

here is named State Dependent Riccati Equation (SDRE). In a first approach, it is considered that all the system states are obtained using specific sensors and are ready for feedback. In a second and more realistic approach, it is considered that some states are obtained using sensors and some states are estimated. The results for the two approaches are compared and discussed. The estimation method used here is the Extended Kalman Filter. The investigation developed here has applications on the study of lightweight robotic manipulators, satellite antennas and solar panels in satellites to quote just a few applications.
Appearance of Chaos is also investigated.
Keywords: flexible structure, nonlinear systems, state estimation, nonlinear control, SDRE

Phase synchronization detection of chaotic noncoherent oscillators

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In this work, we present a new method for measuring the phase of chaotic systems.
This method has as input a scalar time series and operates by estimating a fundamental frequency for short segments, or windows, along the whole extension of the signal. It accomplishes that by minimizing the square error of fitting a sinusoidal function to the series segment. This approach does not require following the trajectory on the attractor, works well over a wide range of adjustable parameters, is very easy to be implemented, and is particularly appealing for experimental settings with single signal outputs since there is no need of attractor reconstruction. It is applicable to both coherent and noncoherent chaotic oscillators. We show the applicability of the method by using two coupled chaotic R"ossler oscillators in coherent and noncoherent cases in order to identify their phase synchronous regimes. We also apply the method to experimental time series obtained from two coupled Chua circuits. The approach shows flexibility and in principle is applicable to any tim! e series suitable for sinusoidal fittings. The use of least square parameter estimation makes the method intrinsically resilient to the presence of noise.
Keywords: Phase synchronization, least-square analysis, Rössler oscillator, Chua circuit

Data assimilation by variational method in diferential equations

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Description of a physical phenomenon through differential equations has errors involved, since the mathematical model is always an approximation of reality.

For an operational prediction system, one strategy to improve the prediction is to add some information from the real dynamics into mathematical model. This aditional information consists of observations on the phenomenon.
However, the observational data insertion should be done carefully, for avoiding a worse performance of the prediction. Technical data assimilation are tools to combine data from physical-mathematics model with observational data to obtain a better forecast. This work present the representer method (a variational tecnique). The performance of the method is evaluated under application to a linear wave propagation equation and shalow the lorenz model.

Chaotic Dynamics In A Population Of Tribolium

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A nonlinear demographic model which has been used to predict the population dynamics of the flour beetle Tribolium was simulated. We used a set of difference equations (the LPA model) which describes the nonlinear life-stage interactions, predominantly cannibalism. Manipulating the adult mortality rate we observed the changes in the dynamics from stable fixed points to periodic cycles and from periodic oscillations to chaos. Phase-space graphs of the data provide evidence of chaotic behaviour. In order to take into consideration, the natural fluctuations, we introduced some noise into the system. Our results show an elongation of the chaotic region.
Keywords: Population dynamics, chaos, difference equation, noise.

Mathematical Modeling Of Impluse Laser Ablation Process Of Metal Target

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In this paper we present model that enables us to determine the ablated matter size and the character of substance distribution on the Zn-target. To study this, we use the equations of the non-stationary heat transfer and the fluids mechanics. The process was simulated with a finite element method(FEM) by means of the software package Comsol 3.5.We consider that during the irradiation phase the surface receives specific power with a Gaussian distribution. We assume that this is a Newtonian fluid and incompressible. In this case, in order to model the movement of the liquid under the effect of recoil pressure, we use the Navier-Stokes equation. The heat conductivity equation takes account of the fluid motion through an advection item. The difference between the solid condition and liquid manifests itself in a very high value of viscosity when the material is in a solid state (temperature lower than the melting point). It is noticed that the depth of the crater is weak at the end of the pulse.

However, after the end of the pulse, the surface remains deformed. This phenomenon can also be observed in the experimental section of the crater after a series of impulses. Crater formation is accompanied drops ablation from crater edges. This confirms that in our case the effect of recoil pressure is definitely more important than the effect of surface tension. The offered model describes a partial version of possible formation of drops.
Keywords: Comsol, laser ablation modeling, heat transfer, zync target, nanopowders

Modeling and Simulation of Possible Controlled and Un-Controlled Launch Modes of a Stratospheric Airship

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Stratospheric Airships are lighter than air high altitude systems which operate in the stratospheric region of the atmosphere finding their use in various military and civilian purposes [1]. Geo stationary Stratospheric Airships can replace geo stationary satellites in the future thereby cutting down huge amount of production cost involved for developing launch vehicles. The airships support themselves at their operating altitudes with the help of buoyancy force, which provides the aerostatic lift, due to which they are very much bulky in nature. Most of the airships use helium as the lifting gas which is lighter than air.
The launching of the airship proceeds with the increase in volume occupied by the lifting gas. In general the airship is divided into two internal compartments one of which houses the lifting gas and the other, air. The compartment in which air is filled is called the ballonet. Another technical term associated with the airship is the inflation ratio, which is, the ratio of volume occupied by the lifting gas to the total volume of the airship. Initially, during the launch, the inflation ratio of the airship is maintained very low when near to the ground. The airship gains altitude when the inflation ratio is increased which is achieved by leaking the air contained in the ballonet. Some airships also use multiple ballonets which are useful for maintaining the attitude and location of center of gravity by differential leakage of air.
With the given mathematical model different trajectories and acceleration, velocity profiles with time can be obtained for different launch modes. This procedure can be followed for any system other than stratospheric airships which are governed by buoyancy and have a ballonet, for example aerostats, new generation weather balloons, etc.

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The Nonlinear Evolution Of Spatial-Temporal Deforestation Patterns

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The Amazon region has a diversity of environments and presents diverse forms of human occupation associated with different actors, economic activities, historical occupancy and strategies of land use and cover. Human activities affect the deforestation patterns and are influenced by both market forces and by public policies implemented in the region. The spatio-temporal evolution of deforestation patterns can occur neatly or chaotically, ie, all its attributes [x, y, z, t] can change randomly. Therefore, this study aims to understand how the nonlinear evolution of deforestation in the Brazilian Amazon could be measured and evaluated.
Keywords: Amazon forest, deforestation, spatial patterns

Nonlinear Programming Methods For Solving Problems: A Recent Bibliographic Review

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A great number of mathematical-programming applications are cast naturally as linear programs. Linear programming assumptions or approximations may also lead to appropriate problem representations over the diversity of decision variables being measured. At other times, however, nonlinearities in the form of either nonlinear objective functions or nonlinear constraints are critical for representing an application properly as a mathematical program. In mathematics, nonlinear programming (NLP) is the process of solving a system of equalities and inequalities, collectively termed constraints, over a set of unknown real variables, along with an objective function to be maximized or minimized, where some of the constraints or the objective function are nonlinear. This paper aims to list several nonlinear programming methods for solving problems that have been published at last 10 years.
Key words: nonlinear programming, methods, bibliographic review

A Complete Model for Calibrating, Controlling And Improving Resolution In AFM

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In this paper a combined methodology for calibrating and controlling an AFM microcantilever is proposed, based on thermal noise and stochastic resonance. The model attempts to analyze the nonlinear dynamic AFM system operating in non-contact mode, enhance resolution in weak periodic signals and control the AFM cantilever tip by locating and avoiding areas of chaotic oscillations.
Initially, the nonlinear equation of motion of the cantilever is numerically solved using the nominal value of the spring constant k. By varying the Z parameter (cantilever-sample distance) or the previously mentioned k parameter in our model, changes in the bistable potential curve of the AFM can occur.
The thermal noise, which is inherent in all AFM systems, is introduced into the time-series model of cantilever fluctuations as an additive stochastic component and couples with the periodic signal that excites the cantilever (stochastic resonance). By fitting the frequency spectrum of the cantilever's response to a Lorentzian line shape, the corrected spring constant can be obtained. For certain k, Z parameters thermal noise can be made optimum for stochastic resonance to happen and thus improve sensitivity in the non-contact AFM mode.
Finally, a control-loop algorithm is introduced into the model. By controlling the driving amplitude of the cantilever's excitation signal, chaotic oscillation areas, which distort the AFM image -presented in previous work-, can be avoided.
The accurate estimation of the cantilever's spring constant leads to traceable force measurements and the control of the cantilever's driving amplitude improves accuracy, aspects very crucial for modern nanometrology applications.
Keywords: thermal noise, stochastic resonance, chaotic oscillation, time-series, nanometrology

Order-Chaos Transitions And Resonances Induced By The Perodic Perturbations

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The addition of a periodic field is very useful in managing the orderchaos transitions and resonance phenomena of pendula and oscillators. This field may eliminate the appearance of deterministic chaos of an underdamped pendfulum.

On the other hand, addition of a multiplicative field with an incommensurate frequency to the overdamped fully deterministic pendulum leads to "erratic" behavior.
The latter, unlike deterministic chaos, is a solution of an integrable differential equation and exhibits a broadband spectrum in the stroboscopic plot of the correlation function, a characteristic usually associated with deterministic chaos. An ineteresting situation occurs when the periodic forcing have equal amplitudes and frequencies, but one enters the pendulum equation additively whereas the second one enters multiplicatively. Then, these two forces act in the opposite directions, and there is no chaotic motion. A detailed analysis is performed of the influence of a second field on the resonance in the Duffing oscillator.
Keywords: Flux Instability, Anisotropic superconductors, Spatial pattern.

Modeling and Simulation of a Reactive Packed Distillation Column Using Delayed Neural Networks

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The complex nature of the reactive packed distillation column owing to the occurrence of both reactions and separations in a single unit brought up the need for the search for a very robust tool of representing the process. In view of this, delayed neural networks are considered as tools that can handle this problem effectively. As such, in this work, Nonlinear AutoRegressive, Nonlinear AutoRegressive with eXogenous inputs and Nonlinear Input-Output models are developed and simulated with the aid of MATLAB R2010b to predict the top and bottom sections temperatures. The predicted results obtained from the Input-Output models were not satisfactory. However, observing the good agreements from the plots as well as the correlation coefficients and the mean squared errors between the predicted results of the NAR and NARX models and the experimental ones showed that these two models can be used to represent the reactive packed distillation column.
Keywords: Reactive packed distillation column, Delayed Neural Network (DNN), Nonlinear AutoRegressive (NAR), Nonlinear AutoRegressive with eXogenous inputs (NARX), Nonlinear Input-Output (IO), MATLAB, Correlation coefficient (R), Mean squared error (MSE).

Sir Pinski Rides Again

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The iterative procedure of removing \almost everything" from an equilateral triangle ultimately leading to the Sierpinski's gasket is well-known.

But what is in fact left when almost everything has been taken out? Using the Sir Pinski's game described by Schroeder [1], we identify two dual sets of invariant points in this exquisite game, and from these we describe the points left over in Sierpinski's gasket.
Keywords: Sierpinski's gasket, fractals.

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Analogue Circuitry Realization Of Neuron Network

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In this paper, some new numerical as well as experimental results connected with simplified neuron model are presented. These neuron models are described by the nonlinear equations. It is proved that from the viewpoint of the global behavior the so-called chaos can be generated. The novel method of connecting the individual neural cells into the large networks is briefly discussed. This approach can be the first step of achieving the artificial intelligence.
Keywords: Chaos, neural model, neural network, artificial intelligence, Hindamarch Rose model.

Chaos and multiple mode spatio-temporal complexity in thermo-visco-elastic systems subject to laser irradiation

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Thermally driven limit-cycle oscillations have been shown to occur beyond a stability threshold of an equilibrium state in mechanical systems that span multiple spatial scales. To date, these systems have been modeled by single-degree-of-freedom resonators coupled to a lumped-mass thermal description. However, while their analysis qualitatively reveals the onset of limit cycle oscillations, the analytically determined thresholds differ from measurements by a factor of two. Furthermore, these systems have been shown experimentally to exhibit irregular vibrations that alternate between several continuous vibration modes which cannot be explained by lumped-mass models. Thus, in order to resolve the spatio-temporal complexity of the near resonance thermo-elastic system response, we formulate an initial-boundary-value problem that is subject to laser irradiation and consistently includes both nonlinear viscoelastic and thermal fields. Numerical analysis of a reduced order model that is deduced from the coupled field equations reveals a complex bifurcation structure that includes coexisting equilibrium solutions, self-excited periodic

oscillations, and chaotic structural response of the thermo-visco-elastic dynamical system.

Keywords: chaos, themo-visco-elastic systems, laser irradiation, self-excited oscillations, bifurcation structure.

Studying Of Radiating Infringements In The Semiconductor Compounds Irradiated γ - Quanta And Protons By Method Of Positron Annihilation Spectroscopy

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In the present work as ADAP method kinetics of process of formations of radiating defects under the influence of proton and γ - radiation and the subsequent annealing in monocrystals of (A^3B^5) semiconductors [1,2] is investigated. The parameters of ADAP spectra characterizing crystal and electronic properties of investigated monocrystals are established. On change of key parameters of ADAP spectra relative changes of accumulation and annealing of defects are investigated at an irradiation and the subsequent isochronous annealing of these samples. In both cases (A^3B^5 compounds) change of parameters of ADAP spectra depending on annealing temperature has the step character interpreted as formation of defects of certain type with various energy of activation of annealing. Changes of parameters of ADAP spectra at annealing of the irradiated samples allows to draw a conclusion on formation in monocrystals and at their irradiation protons not less than three types of radiating defects with various energy of activation of annealing. It is supposed that transitions from one type of defects to another can be considered as possible nonequilibrium phase transition in metal sublattice of crystal (A^3B^5) compounds and [3]: divacancies $\rightarrow$ monovacancies $\rightarrow$ aren't present vacancies.

The consent of the received results with results of similar researches of defect formations at the electronic and neutron irradiation, executed other methods give the grounds to consider a method of positron annihilation spectroscopy perspective and informative for studying of a wide class of materials from metals to dielectrics.

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Non-Linear Time Series Analysis Of Gamma-Ray Burst Phenomena

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Gamma-ray Bursts (GRBs) are the most instantaneously powerful cosmic explosions since the Big Bang known in the universe. They are identified as brief, intense and completely unpredictable flashes of high energy gamma-rays on the sky.
The GRB prompt emissions exhibit a vast range of extremely complex temporal behaviors.
In this work the apparent randomness of the GRB time profiles is investigated making extensive use of advanced nonlinear techniques. We comprehensively analyse the prompt-ray emission of long and bright GRBs detected by the BAT instrument on board the Swift satellite.
Our results strongly suggest that the GRB events are generated by a low-dimensional deterministic dynamic which is superimposed a high amount of random fluctuations.
This new scenario allows us to simplify the physical mechanisms believed to take place in GRBs, as well as, to constrain and test different emission models and more generally the processes underlying the stellar explosions associated to the birth of new stellar-size black holes and "transient" jet/disk accretion systems.
Keyword: astronomy, high energy

Falling of a Passive Compass-Gait Biped Robot Caused by a Boundary Crisis

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The planar passive compass-gait biped robot on sloped surfaces is the simplest model of legged walkers. It is a two-degrees-of-freedom impulsive mechanical system known to exhibit, in response to an increase in the slope angle of the walking surface, a sequence of period-doubling bifurcations leading to chaos before falling down at some critical slope without any explanation. The fall is found to be occured with the abrupt destruction of chaos. We showed recently that a cyclic-fold bifurcation is also generated in the passive walking patterns of the compass robot. The aim of this paper is to show that the fall of the passive compass-gait biped robot occurs via a global bifurcation known as boundary crisis. We show that the cyclic-fold bifurcation is the key of the occurrence of such boundary crisis. We demonstrate how the same period-three unstable periodic orbit generated from the cyclic-fold bifurcation causes the abrupt death of chaos in the passive dynamic walking and hence the fall of the compass-gait biped robot.

Keywords: Compass-gait biped robot, Passive dynamic walking, Chaos, Cyclic–fold bifurcation, Boundary crisis.

Flux Optimization in Field Oriented Control for Induction Machine Drives

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This paper presents a novel strategy to control an induction machine drives with optimum rotor flux that minimizes the power loss under practical currents, voltages and position measurements. Based on strategy of flux optimization method, the implementation of indirect field oriented control for induction machine drives is realised. The improved practical control models are evaluated and confirmed through experiments using an induction machine (1.5kW/380V). Simulations tests are provided to evaluate the performance of the control scheme system.
Keywords: Optimization, Flux, Field Oriented Control, Induction Machine.

Strange Attractors in a Biochemical Process

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In this paper we investigate instability dynamical system using running bioreactor mathematical model. A bifurcation diagram dependent on dissipation parameter of kinetic membrane potential was constructed. Puankare mapping and cut set were constructed too. Creation regular and strange attractors scenario were found. There are two cases of creation attractor, such as a fold and a cone. A full spectrum of Lyapunov exponents was obtained for the bifurcation diagram. Dependences an attractor structure from a quantity of Lyapunov exponents were investigated.
Key words: chaos, structural instability, biochemical process, Lyapunov exponents, self-organization, strange attractor, dissipative system.

Isochronal Synchronization Of Time-Delay And Delaycoupled Chaotic Systems

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This paper studies the problem of isochronal synchronization of timedelay chaotic systems featuring also coupling delay. Based on the Lyapunov-Krasovskii stability theory, sufficient conditions are derived for the

asymptotic stability of bidirectionally delay-coupled chaotic systems featuring intrinsic time-delay. Such conditions allow the proper design of a proportional feedback gain matrix that guarantee asymptotic stability of isochronal synchronization between a pair of identical chaotic systems. The proposed criteria are suited to systems with (i) intrinsic delay, (ii) coupling delay or (iii) both. Numerical simulations of the synchronization of a couple of Rossler systems and then of a couple of Lorenz Hyperchaotic systems are presented as examples of the application of the criteria.
Keywords: isochronal synchronization, chaos, Lyapunov-Krasovskii.

Towards Efficient Solution Of Nonsmooth Dynamical Systems

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It is well-known that smooth dynamical systems can be efficiently solved by adaptive discretization methods based on a posteriori error analysis.
Here we combine adaptive time discretization with special methods to cope with nonsmoothness. Jumps, kinks, and other issues of nonsmoothness are considered as events that have to be detected in the dynamic process and have to be incorporated in the step size control. Such an event detection can be accomplished by an additive zero search of a suitable event function or by solving additionally another differential equation.
Both approaches have been numerically tested in benchmark examples that come from applications in mechanics (frictional contact of a nonlinear spring) and electronics (rectifier circuit).
Keywords: Nonsmooth dynamical system, event detection, adaptive discretization, frictional contact, rectifier circuit

Similarity Measure for Fuzzy Numbers

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Ranking of fuzzy numbers plays a very important role in linguistic decision-making and some other fuzzy application sys- terms. Several strategies have been proposed for ranking of fuzzy numbers. Each of these techniques has been shown to produce non-intuitive results in certain case. This paper proposes a new similarity measure to calculate the degree of similarity of generalized fuzzy numbers. The similarity measure is developed by integrating the concept of centre of gravity points and fuzzy difference of distance of points of fuzzy numbers. A fuzzy description for difference of distances between fuzzy numbers in its turn exploits appropriate similarity measure between the pattern sets when compared with other measures available. It greatly reduces the influence of inaccurate measures and provides a very intuitive quantification. Several sets of pattern recognition problems and a fingerprint-matching problem are taken to

compare the proposed method with the existing similarity measures. Our approach gives a better and more robust similarity measure.

Keywords: Magnitude of fuzzy numbers, Parametric form of fuzzy numbers, Ranking, Trapezoial fuzzy numbers.

Search for Deterministic Non Linearity in the Light Curves of the Black Hole System GRS 1915+105

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GRS 1915+105 is prominent black hole system exhibiting variability over a wide range of time scales and the light curves from the source have been classified into 12 temporal states. Here we undertake an analysis of the light curves from all the states using three important quantifiers from nonlinear time series analysis, namely, the correlation dimension (D2), the correlation entropy (K2) and singular value decomposition (SVD). An important aspect of our analysis is that, for estimating these quantifiers, we use algorithmic schemes which we have proposed recently and tested successfully on synthetic as well as practical time series from various fields. We show that nearly half of the 12 temporal states exhibit deviation from randomness and their complex temporal behavior can be approximated by a few (3 or 4) coupled ordinary differential equations. Based on our results, the 12 states can be broadly classified! into three from a dynamical perspective: purely stochastic with D2 tending to infinity, affected by colored noise and those which are potential candidates for deterministic non linearity with D2 < 4. Our results could be important for a better understanding of the processes that generate the light curves and hence for modeling the temporal behavior of such complex systems.

Key Words: Time Series Analysis, Applied Chaos, Black Hole Binaries

Synchronization In Non Dissipative Optical Lattices

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Optical lattices are one of the most efficient tools to manipulate cold atoms, by tuning or adjusting parameters such as the mesh and height of the sites (atom confinement, atomic density), or the lattice geometry. They became a toy model in many fields. When they strongly interact, cold atoms in optical lattices offer deep similarities with condensed matter systems. They allowed to observe the superfluid-Mott insulator quantum phase transition, the Tonks-Girardeau regime, and more generally the superfluidity properties, including the instabilities.

On the other hand, interesting behaviors are also found in noninteracting systems. In particular, cold atoms in optical lattices made possible the

observation of the transition between Gaussian and power-law tail distributions, in particular the Tsallis distributions. They also allowed the observation of Anderson localization. They also appear to be an ideal model system to study the dynamics in the classical and quantum limits. In non dissipative optical lattices, both the classical and the quantum situations are experimentally accessible, and it is even possible to change quasi continuously from a regime to the other. Moreover, the extreme flexibility of the optical lattices makes it possible to imagine a practically infinite number of configurations by varying the complexity of the lattice and the degree of coupling between the atoms and the lattice. Many results have been obtained during these last years in the field of quantum chaos, mostly using very simple potentials, mainly 1D. For example, chaos is obtained only with a periodic (or quasi-periodic) temporal forcing of the amplitude or frequency of the lattice, and only the temporal dynamics of the individual atoms is studied.

Recently, it appeared necessary to introduce more complex potentials, in particular 2D potentials. Although the dynamics of particles in 2D potential has been extensively studied in the past, it was mainly in model potentials. Experimental optical lattices approach these models at best on a limited domain, at the bottom of the wells. But in most cases, the potential is more complex, and leads to a more complex and richer dynamics. Understanding accurately the classical dynamics of atoms in real potentials is important, in particular because it has significant consequences in the corresponding quantum systems.

The most common approach for the study of complex dynamics in conservative systems is statistical, e.g. evaluating the percentage of the chaotic area in the phase space. However, a more deterministic approach is possible, as in dissipative systems. In a recent study, the dynamics of atoms in different 2D conservative optical lattices were studied and different types of chaotic dynamics were observed, leading to different macroscopic behaviors. It was shown in particular that the lifetime of atoms in the lattices depend drastically on their dynamics.

In a lattice resulting from the interference of 2 orthogonal pairs of counter-propagating stationary waves. The mesh is a square, and the two directions in space are strongly coupled. Therefore the dynamics is expected to be fully chaotic when anharmonicity is high enough, i.e. for high enough energy of the atoms. This fully chaotic regime is effectively observed, except when the lattice is red detuned as compared to the atomic transition. In this case, chaos disappeared almost completely, and the dynamics remains essentially quasiperiodic, although the nonlinearities are the same.

We try to understand here the mechanisms inhibiting appearance of chaos. We show that at the bottom of the wells, the resonance frequencies in both directions are degenerate, but when the atom energy increases, this degeneracy should obviously disappear because of the anharmonicity of the potential. However, we show that the motions in both directions remain locked to the same frequency on a large domain, following a synchronization mechanism close to the frequency locking process of dissipative systems. Because of the conservation of energy, it is not a strict frequency locking, but the quasiperiodic regime appears to be mainly a frequency locked periodic regime with small sidebands. Even when the edges of the wells are approached, chaos appears very marginally, in a regime where the frequencies remain locked. This synchronization, not as strict as that of a dissipative system, is nevertheless a mechanism powerful enough to explain that chaos cannot appear in such conditions.

Study On The Vorticity In A Cavitation Process Produced By A Centrifugal Pump

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We study the pressure field and the velocity field for a water flow where cavitation is present. The system is a closed circuit where water moves by the action of a centrifugal pump. Firstly, we determine the dependence of the cavitation emergence and intensity on the suction height, the volume flow rate, water temperature and the power of the centrifugal pump. We use light scattering to estimate bubble emergence, and a high-speed camera to study the bubble spatial distribution and to search for coherent structures. These scattering experiments are used to estimate the bubble mean size, showing how it depends on the flow Reynolds number. Since the bubbles migrate against the pressure gradient, we use this property to detect low pressure regions, which correspond to high vorticity regions. This relation has been pointed out in the recent literature.

Pinning Control For Stochastic Systems With Functional Uncertainty

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Theoretical development on pinning control of complex dynamical networks have mainly focused on the deterministic version of the model dynamics. However, the dynamical behaviour of most real networks is often affected by stochastic noise components. In this paper the pinning control of a stochastic version of the coupled map lattice network with spatiotemporal characteristics is studied. These complex dynamical networks are shown to have functional uncertainty which should be considered when calculating the optimal control efforts. Two feedback control methods are considered: the conventional feedback control and the stochastic feedback control. It is shown that the frequently used conventional control method suffers from the ignorance of models' uncertainty, therefore, performs unsatisfactorily. To reemphasize the current work will address the following questions: (1) What types of controllers may be designed to improve the synchronization of complex networks characterized by functional uncertainties (2) What are the consequences of the exact knowledge assumption (3) What is the effect of functional uncertainties on the synchronization problem.

Control of Chaos in SIRC Model

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In this paper we deal with one of the Infectious Diseases models named SIRC. In accordance with previous studies, this model has a rich variety of behaviors, including chaos and multi stable periodic outbreaks.
Chaos is undesirable in many applications of the system performance and restrict the systems operating rang. Therefore the problem of controlling chaos has been interesting in recent years. This paper examines chaos control of SIRC model that is chaotic system in particular rang of that is contact rate.
Keywords: Chaotic models, chaos control. SIRC model

Influence Of The Simulation Model On The Spatial Arc Resistance Distribution Of An Axially Blown Switching Arc

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Circuit breakers are important elements of the electric power supply system. They are necessary for the safe switching of rated and short-circuit currents. Today's high voltage power supply system's predominantly make use of self blast circuit breakers. They operate with sulphur hexafluoride (SF_6) as insulating and cooling gas. Due to the contact separation during the switch-off process an electric arc is formed within the circuit breaker. By cooling with a forced flow of the insulation medium the energy is withdrawn until the arc is extinguished. Simultaneously the resistance of the arc rises. The value of the resistance and its distribution along the arc is the crucial factor for the switch-off process to be successful.
Research and development projects related to circuit breakers deal more and more with computational fluid dynamics (CFD) simulations. These simulations can replace expensive experiments and allow the visualization of physical values which are not – or only very difficult – accessible in experimental investigations. Thus, they can also improve the understanding of the physical processes in the plasma of the electric arc during the switching operation of a self blast circuit breaker.
Therefore the implemented simulation models must be verified on the basis of adequate experiments. This paper deals with the influence of the simulation model on the spatial arc resistance distribution near current zero. The arc resistance is mainly influenced by the convective and turbulent cooling of the quenching gas flow. The convective cooling dominates at the stagnation point, the turbulent cooling in the outer nozzle areas. This leads to a non-linear arc resistance distribution near current zero. Hence, the simulation models need to consider both cooling mechanisms. Different approaches for modelling the turbulent and chaotic phenomena of the arc are introduced and their results compared with values measured in experiments. Here the turbulence model and

the three dimensional non-symmetric behaviour of the arc are of main interest. On the one hand the investigations show a good agreement between simulative and experimental results when using adequate models. On the other hand the choice of these models is dependent on the specific problem.

Keywords: CFD-simulations, circuit breaker, high voltage, arc, arc resistance, spatial resistance distribution, chaotic modeling, turbulence, turbulence model

Chaos and suppressing chaos in a pump-modulated Nd:YVO4 laser with reshaping modulation profile

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This work investigates chaos and suppressing chaos in a pump-modulated Nd:YVO4 laser with varying the shape of modulation profile. Modulations with sinusoidal wave and square wave were examined. The laser exhibits chaotic behavior when modulation frequency is adjusted close to the relaxation-oscillation frequency and modulation depth is greater than a threshold. Results show that the threshold for chaotic behavior under square-wave modulation is lower than that under the sinusoidal-wave modulation. Moreover, the suppression of chaos in a Nd:YVO4 laser by biharmonical pump modulation (the first for chaos-inducing and the second for chaos-suppressing) was demonstrated. When the first sinusoidal-wave modulation induced the chaotic behavior, adding the second signal with subhamonic and a specific phase difference to the first modulation signal will reshape the modulated waveform of the pump beam to suppr! ess the chaotic behavior produced by the first modulation. The threshold of the second signal for suppressing chaos under square-wave modulation was also lower than that under the sinusoidal-wave modulation, and the region of chaos suppression in modulation-depth-to-phase diagram overlapped. In addition to the dynamic parameters of modulation frequency and modulation depth, the modulation shape is also an important parameter for inducing and controlling the nonlinear dynamics in pump-modulated lasers.

Keywords: Chaos, Diode-pumped, Solid-state lasers.

Suppressing chaos to completely Kerr-lens mode-locking via self-focusing

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We numerically study suppressing chaos to reach completely mode-locking in a self-starting Kerr-lens mode-locked (KLM) laser. By using the Collins integral and rate equations with and without the self-focusing effect, we found

without the self-focusing effect typical laser output and the feature of a power dip agrees with the observation of experiment for all calculated cavity configurations around the degeneracy at various pump powers. However, by including the self-focusing effect, the time evolution of the pulse-train envelope presents various states including continuous wave or periodic state and instability such as period, period-2, and irregular states. The simulated self-starting KLM output, which possesses transient irregularity before reaching a constant amplitude output, occurs between the instability and continuous wave regions. The different runs of the simulated self-starting from the spontaneous emission reveal the buildup time of mode-locking not only is sensitive to the initial condition but also presents the distribution with exponential decay. Its return map presents chaotic state with a strange attractor in the initial stage. It transits to the quasi-periodic state, which exhibits the property of self-similarity, and finally converges to a fixed point with time evolution.
Keywords: Chaos, Mode locked laser, Kerr effect, Self-focusing.

Using Average Mutual Information to Guide Nonlinear Noise Reduction

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The power spectra of nonlinear time series often contain relevant information across all the frequencies in the spectrum. Traditional filtering results in a loss of information at the high frequencies. Nonlinear local projective noise reduction is a method that allows us to reduce noise while keeping high-frequency information. The data for a period-doubling star are discussed as an example of average mutual information (AMI) serving as a guide to the limits to which nonlinear noise reduction can be taken. The phase-space portraits for this star are investigated at different times during the evolution of the system. The AMI indicated that the periodicities present consist of a “comb” of frequencies with three smaller sub-harmonic peaks in between subsequent primary peaks. Nonlinear noise reduction was most effective for segments of the light curve with a developed surface in phase space allowing us to observe all the frequencies indicated by the AMI.

Dissipative Solitons: The Structural Chaos And The Chaos Of Destruction

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Dissipative soliton, that is a localized and self-preserving structure, develops as a result of two types of balances: self-phase modulation vs. dispersion and dissipation vs. nonlinear gain. The contribution of dissipative, i.e. environmental, effects causes the complex “far from equilibrium” dynamics of a soliton: it can develop in a localized structure, which behaves chaotically. In this work, the chaotic laser solitons are considered in the framework of the

generalized complex nonlinear Ginzburg-Landau model. For the first time to our knowledge, the model of a femtosecond pulse laser taking into account the dynamic gain saturation covering a whole resonator period is analyzed. Two main scenarios of chaotization are revealed: i) multipusing with both short- and long-range forces between the solitons, and ii) noiselike pulse generation resulting from a parametrical interaction of the dissipative soliton with the linear dispersive waves. The noiselike pulse is characterized by an extremely fine temporal and spectral structure, which is similar to that of optical supercontinuum.

Keywords: Dissipative soliton, Complex nonlinear Ginzburg-Landau equation, Chaotic soliton dynamics.

Detection Of Jet Axis In A Horizontal Turbulent Jet Via Nonlinear Analysis Of Minimum/Maximum Temperature Time Series

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We analyzed experimental temperature time series from a horizontal turbulent heated jet, in order to identify the jet axis using non linear measures. The analysis was applied both on the original time series as well as on the extreme value (minimum and maximum values) time series. We employed linear measures such as autocorrelation, power spectrum, and non linear measures such as mutual information and cumulative mutual information. The results show that the analysis of the extreme values time series using cumulative mutual information permits to discriminate the jet axis time series from the rest of the jet. Furthermore, it is of interest that the use of simple statistical measures and clustering techniques shows that the use of extremes time series let us discriminate with greater confidence the jet axis than the use of the original time series.

Keywords:non-linear time series analysis, turbulence, mutual information, cumulative mutual information, clustering

Mathematical Model Operation Of Processes Photoinduced Unstable Stabilities In Solutions Of Anthraquinone

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The dynamic behavior of chemical systems in nonequilibrium area is described by the kinetic equations considering the carry-over phenomenon:

$$\frac{\partial c_i}{\partial t} = f_i\left(\{c_i\}\right) + D\nabla^2 c_i$$

,

$$D\nabla^2 c_i = D_i\left(\frac{\partial^2 c_i}{\partial x^2} + \frac{\partial^2 c_i}{\partial y^2} + \frac{\partial^2 c_i}{\partial z^2}\right)$$

where - nonlinear functions of concentration, - a diffusive member.
Boundary conditions are set in the form of a stream or concentration on a limiting surface (Neumann's conditions and Dirichlet's accordingly).
The effect of the spatial temporal structures (STSes) formation and their development of as a phenomenon of carry-over in the form of redistribution of luminescing photoproduct concentrations was examined in a reactive zone of oxygen-saturated systems "anthraquinone–isopropyl alcohol" by proceeding photochemical processes, initiated by ultra-violet radiation. [1]
It was found that presence in samples of the dissolved oxygen is a necessary condition of the STSes formation.
The fall of oxygen concentration in solutions, caused by photochemical transformations, give effect of photo stratification [1]. In the examined systems with the initial homogeneous spatial reagents distribution there is an uneven transition to the mechanism of transformations, characteristic for deaerated solutions, in separate layers.
It was found that the effect of photo stratification can take place only in that case when previous decrease of oxygen concentration it at the expense of photochemical processes occurs faster, than alignment of concentration at the expense of diffusion in a layer and oxygen transport in a solution through the interface solution—air.
The following assumptions are entered for numerical model operation of processes proceeding in a solution:
– processes in a reactionary zone are carried out faster in comparison with the oxygen diffusion in this zone from environment;
– concentration of molecules of spirit is great enough, therefore decrease of the last during reaction in comparison with reduction of anthraquinone molecules concentration can be neglected.
The system of the differential equations following from the kinetic scheme of reactions has been solved at various initial values of concentration of starting reagents.
The variation of initial concentration of oxygen has allowed explaining of its influence on the induction period, namely: higher growth of the triplet condition "traps" of oxygen is observed with decrease of initial oxygen concentration.

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Projective synchronization of different chaotic discrete-time neural networks with delays, based on impulsive controller

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In this paper, an impulsive control approach is presented for the projective synchronization of two different chaotic Hopfield-type discrete-time neural networks with delays. The global asymptotic stability of the error dynamical system is studied, using linear matrix inequalities, vector Lyapunov functions and the stability theory of impulsive systems. Simulation examples are given to illustrate the feasibility and effectiveness of the proposed approach.
Keywords: projective synchronization, impulsive control, neural network.

Simulation of Content-Driven Cosmic Expansion

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The standard cosmic expansion model, in which gravity acts to decelerate the expansion, has its problems. This paper explores an alternative model, which has a content-driven mechanism, and in which gravity does not play a role in the overall expansion. Cosmic expansion was simulated with a three-step iterative algorithm, three fundamental parameters, and Planck-scale initial conditions. Model characteristics include self-regulated expansion, causal mechanisms for the Big Bang and Inflation, non-fundamental time (t), parametric Ht (the product of t and the Hubble parameter (H)), a dynamic deceleration parameter (q), Ht lagging $(1+q)^{-1}$, and attractors in the q-Ht phase diagram. Simulation results support refinement of the standard model and open the door for similarly exploring and comparing other cosmic expansion models.
Keywords: cosmology, modeling, simulation, complex systems

Chaotic dynamics in microtubulin dimers

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We investigate the microtubulin oscillations which can be periodic as well as chaotic in appropriate parameter domains. The chaotic aspects of microtubulin dynamics presented here are new and highlighted appropriately.

Chaos is a very interesting nonlinear phenomenon. The dynamical chaos is a phenomenon that can be described by mathematical models for many natural systems, for example, physical, chemical, biological, and social, which evolve in time according to a deterministic rule and demonstrate capricious and seemingly unpredictable behavior. The long term dynamics of any deterministic system can either be stationary, periodic, quasiperiodic or chaotic. Chaotic solutions of nonlinear differential equations are characterized by their extreme sensitivity to initial conditions. Nonlinear differential equations are very important in biology, because they can exhibit formation of spatiotemporal patterns and stab! ,β-tubulin that can switch between growing and shrinking phases. MTs participate in a wide variety of dynamic cellular processes ranging from mitosis to signal transduction, to information processing. During cell division they se!ale time-dependent oscillations, as well as switching from one type of behavior to another. If we consider the adaptation of an organism to some kind of change in external conditions, or the processing of information in the brain, or the growth of a multicellular organism from a single embryonic cell, such problems cannot be addressed in a quantitative way without using nonlinear differential equations. Microtubule (MT) is one of the most essential cytoskeletal elements in the eukaryotic cells, which supports the mitosis, cell architecture and motility as well as the intracellular transportation. Tubulin dimers in a GTP-binding state (GTPtubulin) are assembled onto MT-ends and make them stable. Microtubules are essential cytoskeletal polymers of rve as a kind of track for the transport of chromosomes. In the neuron s they are the pathway for the transport of neuronal vesicles towards the synapse. In non-dividing cells they form a network in the space between the nucleus and the cell membranes being possibly involved in the transport of material from the surface to the center and vice versa. We propose to investigate the chaotic dynamics of microtubulin dimer oscillations existing in two spatial conformations. The electron responsible for switching between the conformations is in the form of a double-well potential. The existence of different conformations seems to be due to the fact that there is an electron at the center of the dimer (in its water-free part) that may reside in one of two possible positions.
Keywords: Chaos, Microtubules and Differential equations

An application of chaotic Chua's system for secure chaotic communication based on sliding mode observer and its circuit implementation

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In this paper, we study the design and implementation of analog secure communication systems via synchronized chaotic Chua's circuit with sliding mode observer. For this, we adopt an approach based on an inclusion of the message in the transmitter and in the receiver, we use a sliding mode observer with un-known input in order to recover the information. Finally, an analog electronic circuit with Multisim software is designed to physically realize the complete system (transmitter-observer).

Keywords: chaotic Chua's system, sliding mode observer, secure communication, Synchronization;

Hamilton equations of general relativity in Observer's Mathematics

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This work considers the Hamilton equations of general relativity in a setting of arithmetic, algebra, topology provided by Observer's Mathematics (see www.mathrelativity.com) and applies this solution to the Euler-Lagrange theory. Certain results and communications pertaining to solution of these problems are provided.
Keywords: Euler, Lagrange, Schrodinger, Einstein, general relativity, Hamilton, observer

Decentralized adaptive backstepping controller Design: application to multimachine power systems

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In this paper, a decentralized adaptive backstepping controller with tuning functions is designed for stability enhancement of multimachine power system. The proposed design on the i^{th} synchronous generator uses only local information and operates without the need for remote signals from the other generators. A modified fourth-order nonlinear model of a synchronous generator is considered on the control design. The controller is designed using backstepping technique, the tuning function is considered to decrease the dynamic order of the controller to its minimum. A 3-machine power system is used to demonstrate the effectiveness of the proposed controller over the conventional damping controller (power system stabilizer) techniques.
Keywords: Decentralized control, adaptive backstepping control, tuning functions, multimachine power systems.

Pattern Formation of the Stationary Cahn-Hilliard Model

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We investigate critical points of the free energy of the Cahn-Hilliard model of a binary alloy under the constraint of a constant mass. The domain is the unit square. Minimizers of the energy without interfacial energy term are given by a decomposition of the two components of the alloy, but the interfaces

between the components are arbitrary. Specific patterns are only formed if an interfacial energy term is present. We select such patterns of minimizers by an approximation of sequences of conditionally critical points of the free energy when the interfacial energy term tends to zero. This is what we call Pattern Formation of the Stationary Cahn-Hilliard Model. Mathematically it is a singular limit process.
We obtain the conditionally critical points by a global bifurcation analysis of the Euler-Lagrange equation for the free energy where the mass is the bifurcation parameter. The eigenvalues of the linearization at the trivial solution, which is given by a homogeneous mixture, define the bifurcation points. The corresponding eigenfunctions have characteristic symmetries over the unit square, and the elliptic maximum principle implies that these symmetries, in particular the location of the maxima and minima, are fixed for all solutions of the nonlinear equation on global bifurcating branches. These properties allow a uniform a priori estimate of the branches and also the existence of a singular limit as the interfacial energy term tends to zero. This limit is a nontrivial conditionally critical point and by its symmetries it fulfills the Weierstrass-Erdmann corner conditions known from one-dimensional calculus of variations. Therefore the limit is a minimizer of the free energy without interfacial energy term whose pattern is formed by the singular limit process. This process can be done for all bifurcating branches and for all masses in the so-called spinodal region.

Nonlinear Determinism and Noise Effect in Radar Rainfall

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This study investigated nonlinear characteristics of hydrologic time series which may have chaotic system or nonlinear stochastic system and also investigated noise reduction techniques which can eliminate noise involved in time series. We generated chaotic series from Logistic map and Lorenz system and added noise to the series to investigate noise influence. We performed some analyses such as Close Returns Plot(CRP) and BDS statistic which are known as the methods of nonlinear deterministic or chaotic analysis. If we see the results of analysis, the characteristics of data series are gradually changed from nonlinear chaotic data series to random stochastic data series according to increasing noise level. Chaotic analysis also performed for the climate time series such as GSL(Great Salt Lake, USA) volume series and radar rainfall series. We applied Low Pass Filter and Kalman Filter techniques for the investigation of noise reduction effect of the added noise to data series. Typical nonparametric method cannot distinguish nonlinear random series but the BDS statistic can distinguish the nonlinear randomness of the time series. Therefore this study used the BDS statistic which is well known as nonlinear statistical method for the investigation of randomness of time series and for the effect of noise reduction of data series. We found that Kalman filter is better method to remove the noise of chaotic data series even for high noise level. And, we also

found that the techniques can be applied to the real climate data series such as GSL volume series and radar rainfall series.

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Keywords: Radar rainfall, Close Returns Plot, BDS statistic, Noise, Filtering Technique

Investigating Nonlinear Dependence of Time Series Using BDS Statistic

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It has been a common practice to employ the correlation dimension method to investigate the presence of nonlinearity and chaos in hydrologic processes. Although the method is generally reliable, potential limitations that exist in its applications to hydrologic data cannot be dismissed altogether. As for these limitations, two issues have dominated the discussions thus far: small data size and presence of noise. Another issue that is equally important, but less discussed in the literature, is the selection of delay time (τd) for reconstruction of the phasespace, which is an essential first step in the correlation dimension method, or any other chaos identification and prediction method for that matter. It has also been increasingly recognized that fixing the delay time window (τw) rather than just the delay time itself could be more appropriate, since the delay time window is the one that is of actual interest at the end to represent the dynamics. To this effect, Kim et al. (1998a) [Phys Rev E 58(5):5676–5682] developed a procedure for fixing the delay time window and demonstrated its effectiveness on three artificial chaotic series, and followed it up with the development of the C–C method to estimate both the delay time and the delay time window. The purpose of the present study is to test this procedure on real hydrologic time series and, hence, to assess their nonlinear deterministic characteristics. Three hydrologic time series are studied: (1) daily streamflow series from St. Johns near Cocoa, FL, USA; (2) biweekly volume time series from the Great Salt Lake, UT, USA; and (3) daily rainfall series from Seoul, South Korea. The results are also compared with those obtained using the conventional autocorrelation function (ACF) method.

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Keywords: Chaos, Correlation dimension, Delay time, Delay time window, BDS statistic, C-C method

Dynamical behaviour of semiconductor ring laser subject to incoherent optical feedback

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We numerically investigate the dynamics of a semiconductor ring laser (SRL) subject to incoherent optical feedback (IOF). We find that, under certain conditions, its two counter-propagating modes display continuous waves, periodic, quasi-periodic and chaotic behaviour. Besides, the intensities of the counter-propagating modes may exhibit in-phase and out-of-phase chaotic regimes respectively for delay time comparable to the period of relaxation oscillation and significantly higher than the period of relaxation oscillation.
Key words: Dynamics, incoherent optical feedback, in-phase and out-of-phase chaotic regimes, period of relaxation oscillation.

Magnetic field effects on chemical reactions near the disturbance of stationary states conditions

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The influence of magnetic fields on chemical processes has long been the subject of interest to researchers. For this time numerous investigations show that commonly the effect of a magnetic field on chemical reactions is insignificant with impact less than 10 percent. However, there are some papers that point to the observation of external magnetic field effect on chemical and biochemical systems actually having a significant impact on the reactions. The reason of the effect should be based on searching physically clear processes which mechanisms are well investigated.
The paper theoretically deals with two models explaining how an applied week magnetic field might influence the steady state of a non-equilibrium chemical system. It is speculated that an applied weak magnetic field might induce a slight change of some rate constants of radical reactions involved in the chemical system. This, in turn, leads to a bifurcation of steady states and implies an abrupt change in temperature and concentration.
Keywords: radicals, recombination, magnetic effects, stationary states, critical phenomena, photochemical system, chain reactions with degenerate branching.

Combined influence of electro-mechanical parameters and inertial properties on the dynamics of VAWT and VAHT

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Closed electro-mechanical model of vertical axis wind turbine (VAWT) is studied. The same model can be applied for a similar hydro turbine (VAHT). The model contains two principal dimensionless parameters: one of them is responsible for inertial properties of the turbine, and the other characterizes electro-mechanical properties. The combined influence of these two parameters on the turbine dynamics is studied. Some differences between the turbine behavior in the air and in the water are shown. Advantages and disadvantages of using changeable moment of inertia as a control parameter of the turbine are discussed in application to the following tasks: increasing of output power, improvement of transition processes.

Chaos in three level system due to the relative phases of the driving fields

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Three level system interacting with three laser fields is considered in the framework of semiclassical approximation. We present the relevant Hamiltonian and solve the corresponding time dependent master equation for the system's density matrix and calculate the spectra of the induced coherences. The spectal behavior depends crucially on the relative phases of the driving laser fields. We will demonstrate chaotic spectra resulting from some peculiar relations between the phases of the driving fields and other parameters of the fields.

Power invariants for theory of synthesis of oscillation systems

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In the paper we explore synergetic approach to synthesis of self-oscillated systems based on famous method of analytical design of aggregated regulators.

We solve the famous problem of “inverted pendulum" vertical position control basing on power approach and method of analytical design of aggregated regulators. We have built new models of oscillation generators with inertial nonlinearity that are overcome generators of known types, and, therefore, may be applied for creation of many self-oscillation systems including ones with dynamics chaos.

Scientific school of Southern Federal University (Russia) of nonlinear dynamics and system synthesis

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One of the fundamental and urgent problems of the modern science of complex systems is the development of highly efficient application of the theory of nonlinear system synthesis. Meanwhile, despite the large global contingent of scientists and a large number of publications, practical progress in systemic synthesis problems solutions is focused mainly to the computerization based on the already well-known classical principles, i.e. spread them more breadth than depth. Although the science of systems analysis, control and information processing in XX century transforms into stand-alone discipline as a result of its rapid development, but the applied science of complex system control has not received the necessary development and lags behind the needs of the practice. This fact underline the fundamental issue of finding common objective laws of the unity of self-organization and control - the feedback, which reduces to the maximum allowance for the natural properties of the object of corresponding nature. Recent advances of nonlinear science - synergetics and the theory of self-organization allow us to hope that the theory of system synthesis, like other sciences, can go through the course, with a view to moving to a new conceptual framework.

We emphasize that the problem of constructing a system of regularities has long been one of the most pressing issues in science. Therefore, any progress towards its solution has important scientific significance. As was pointed out by V.I. Vernadsky, the future science will be shaped not by a narrow disciplines and specialties, as was the case hitherto, but by fundamentally scientific problem. In our case - it is post-non-classical key concept of unity of self-organization and control that permeates all contemporary knowledge of touch and living nature, technology and society. This and other related issues are explored in report in details.

The theory of integral adaptation of nonlinear systems on invariant manifolds: the worst disturbances

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In the report we proposed a new method of adaptive control of nonlinear objects based on the idea of introducing the appropriate control channels of integrators that can synthesize the adaptive system without extracting current information about variations in the object and external environment. Herein lies the fundamental difference between the new method from known methods of the theory of adaptive control.

The report's basic tenets of the theory and method of integrated systems to adaptation on the invariant manifolds have proven highly effective in solving problems of complex dynamic objects control. These problems cause significant difficulties for the well-known methods of adaptive control. Proposed in the report a synergistic approach allows us to create a new direction in the theory of nonlinear adaptive control.

Synergetics method of system synthesis for data chaotic-dynamics processing and securing

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In the paper we propose new method of data chaotic-dynamics processing and securing. This method is based on reconstruction of system's dynamics, provided by synergetics observer. By using this method we provide a good accuracy for control parameter estimation as well as good reconstruction of initial data signal. So, we can apply this method to hidden data transmission via communication channels and use oscillations of chaotic generators as a signal carrier.
Keywords: dynamics system, chaos, attractor, synergetics observer, chaotic generator, data securing

The problem of risk management for society of risk: social invariants

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We explore modern Russian society as a society of extreme social inequalities, and examine the processes of harmonization in the sphere of social and labor relations. In this case, we set the following main objectives: firstly, to develop conceptual synergistics principles and practices of crisis management of social risks as the current strategic direction of crisis management in social systems; and secondly, to identify fundamental system-social invariants, i.e. attractors; and, thirdly, to develop synergetics model of harmonious risk management in the social sphere. The novelty is the determination of optimal mechanisms of crisis management of social risks, based on the principle of unity of social organization and governance. As a result we present a model of crisis risk management, in which the base category is a deliberate self-organization; we present synergetics principle of harmonization of social systems, based on the properties of the "golden ratio" as a fundamental backbone of the invariant; we investigated the social and labor sphere in terms of production risk, which revealed the most "pain points" of this sphere; we propose the law of work reward (promotion) system harmonization, which revealed that "risk parameter" as "social strain". On the basis of the law we propose the most appropriate

mechanisms for regulating social and labor sphere in a society of social inequality.
Keywords: golden section, social-economics system, invariant, self-organization, social strain, social risks, labor pay system.

Fluid mixing in finite vortex structures

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Considered two of the vortex structure, each of which consists of lying on a straight line vortices. The first structure consists of three vortices, the second has five. Considered the motion of the structures and fluid mixing under the influence of these structures.
Keywords: Contour tracking, Fluid mixing, Simulation, Vortex.

A sub microscopic description of the formation of crop circles

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We describe a sub microscopic mechanism which is responsible for the appearance of crop circles on the surface of the Earth. It is shown that the inner reason for the mechanism is associated with intra-terrestrial processes that occur in the outer core and the mantle of the terrestrial globe. We assume that magnetostriction phenomena should take place at the boundary between the liquid and the solid nickel-iron layers of the terrestrial globe. Our previous studies showed that at the magnetostriction a flow of inertons takes out of the striction material (inertons are carriers of the field of inertia, they represent a substructure of the matter waves, or the particle's psi-wave function; they transfer mass properties of elementary particles and are able to influence massive objects changing their inner state and behaviour). At the macroscopic striction in the interior of the Earth, pulses of inerton fields are irradiated, and through non-homogeneous channels of the globe's mantle and crust they reach the surface of the Earth. Due to the interaction with walls of these channels, fronts of inerton flows come to the surface as fringe images. These inerton flows affect local plants and bend them, which results in the formation of the so-called crop circles. It is argued that the appearance of crop circles under the radiation of inertons has something in common with the mechanism of formation of images in a kaleidoscope, which happens under the illumination of photons.
Key words: crop circles, inertons, mantle and crust channel, magnetostriction of rocks

Research of stability and controllability performance of nonlinear multidimensional dynamic object

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The aircraft which behavior is described by the laws of mechanics of rigid bodies in tridimensional space is an object of exploration. Nonlinearity of mathematical model of the aircraft is an effect of complex relationships between aerodynamic forces, moments and variable conditions of external environment distortions. Variety of statement applications of those tasks that are solved during different stages of the aircraft flight requires pilot to perform interactive managing of the aircraft motion. The following two tasks must be resolved while managing the flight: provision of specified invariants (or goals); counteract the distortions caused by environment or nay occasional effects.
Both of foregoing tasks may be resolved provided that the aircraft has sufficient and adequate stability and controllability.
To research stability and controllability performance of the aircraft there has been developed an aircraft disturbance mathematical model using Matlab/Simulink software. There has been performed research of aircraft basic motion, wherein desirable system invariants are realized each moment and the moments applied to the aircraft are balanced. During investigations of dynamics of the object under control at environment distortions, managing effects performed by pilot or autopilot system, propulsion and control system failures there have been obtained the relationships of the phase variables versus time that are transient processes qualifying dynamic stability and controllability of the aircraft. The phase patterns having been obtained during analysis process of the dynamics of the nonlinear object under control have enabled to verify the domain of attraction that are the system attractors.
Keywords: stability, controllability, nonlinear dynamic object.

Spatio-temporal Chaos in the transverse Section of wide Aperture detuned Laser

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In this paper we investigate spatio-temporal dynamics of wide aperture laser with frequency detuning. Dynamics of the laser is described by simple Maxwell-Bloch model. We investigated both self-similar and spatio-temporal solutions of equations. It is shown that homogenous equilibrium state of Maxwell-Bloch equations proves to be unstable in some area of laser parameters. It is shown that for the self-similar solutions passage to the chaotic regime during a change in the wave propagation velocity across the aperture occurs via the torus doubling bifurcations. The spectrum of Lyapunov exponents is found and it is established that at bifurcation points a structurally unstable three-dimensional

torus is produced, which gives rise to a stable doubled ergodic torus [1]. Spatio-temporal dynamics on finite aperture are close to self-similar solutions described above. It is shown that at certain values of laser parameters autowaves propagating across the aperture are observed. In this laser system, it is shown the transition to spatio-temporal chaos via the cascade of tori doubling bifurcations.
Keywords: torus doubling bifurcation, chaos, wide-aperture laser, autowaves.
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A model of forming planetary orbits in the Solar system based on the statistical theory of spheroidal bodies

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In this work, we consider a statistical theory of gravitating spheroidal bodies to explore and develop a model of forming and self-organizing the Solar system. It has been proposed the statistical theory [1]–[3] for a cosmological body forming (so-called spheroidal body) by means of numerous gravitational interactions of its parts (particles). The proposed theory starts from the conception for forming a spheroidal body inside a gas-dust protoplanetary nebula; it permits us to derive the form of distribution functions, mass density, gravitational potentials and strengths both for immovable and rotating spheroidal bodies as well as to find the distribution function of specific angular momentum. As the specific angular momentums are averaged during conglomeration process, the specific angular momentum for a planet of the Solar system (as well as a planetary distance) can be found by means of such procedure. The problem of gravitational condensation of a gas-dust protoplanetary cloud with a view to planetary formation in its own gravitational field is also considered here [2]. This work considers a new law for the Solar system planetary distances which generalizes the well-known Schmidt law [1], [2]. Moreover, unlike the well-known planetary distances laws the proposed law is established by a physical dependence of planetary distances from the value of the specific angular momentum for the Solar system.

It has been noted in [1] the proposed simple statistical approach to investigation of our Solar system forming describes only a natural self-evolution inner process of development of protoplanets from a dust-gas cloud. Naturally, this approach however does not include any dynamics like collisions and giant impacts of protoplanets with large cosmic bodies. Henceforth, the presented statistical theory will only be able to predict surely the protoplanet's positions according to the proposed ent[n/2] rule [1], [2], i.e. the findings in this work are useful to predict if today's position or orbit of a considered planet coincides with its protoplanet's location or not.

Let us note that orbits of moving particles into the flattened rotating spheroidal body are circular ones initially. However, these orbits could be

distorted by collisions with planetesimals and gravitational interactions with neighboring originating protoplanets during evolutional process of protoplanetary formation. Really, at first the process of evolution of gravitating and rotating spheroidal body leads to its flattening, after that the evolutional process results in its decay into forming protoplanets. Consequently, the orbits of moving particles are formed by action of centrally-symmetrical gravitational field mainly on the later stages of evolution of gravitating and rotating spheroidal body, i.e. the particle orbits become Keplerian ones. In this connection this work investigates the orbits of moving planets and bodies in centrally-symmetrical gravitational field of gravitating and rotating spheroidal body during the protoplanetary stage of its evolution.

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Numerical study of kinetic Alfvén wave excitation by magnetosonic wave in high beta plasmas

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This paper presents the model equations governing the nonlinear interaction between kinetic Alfven wave (KAW) and magnetosonic wave in the high-β plasmas (β□□; known as kinetic Alfvén waves (KAWs)). This nonlinear dynamical system of equations may be considered as the modified Zakharov system of equations (MZSE) by taking the non-adiabatic response of the magnetic field and background density. We solved these model equations numerically by using pseudo-spectral method. The localized magnetic filamentary structures are found in solar wind (1AU) associated with the KAWs. The power spectra of magnetic field fluctuations indicate that the nonlinear interactions between KAW and magnetosonic wave may be redistributing energy among higher wavenumbers. We observed two types of scaling and . Relevance of these investigations to the high-3.4k−3.6k−β plasmas in solar wind has been pointed out. The acceleration of the solar wind and plasma heating may be produced by the coupling of KAW and magnetosonic wave via filamentation process.

Dynamics Of Modern Educational Space In Context Of Synergetic Ideas

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The given work is devoted to consideration of the processes occuring in modern educational space.
Reforming of higher education system in Russia is characterized by search of optimum conformity between the developed traditions in Russian higher school and the new trends connected with ocurrence in world educational space.
Synergetic paradigm is considered as a basis of modern formation methodology progress. On the basis of research of synergetrics use experience in interdisciplinary researches problems of synergetic ideas use in pedagogics and formation which are actual for pedagogics of the modern higher school are designated. Synergetic approach releases pedagogical space from one-linearity and stamps, opens polyfunctionality and multidimensionality of hypotheses and theories, allows to comprehend in a new fashion features of creative thinking and imagination, to estimate constantly updated variety of ways, methods, principles of progress of the creative person to create new conditions for disclosing creative capacities.
Keywords: Synergetics, Multidimensionality, Education, Formation, Methodology, Linearity, Pedagogics.

Synergetics approach to vessel turbine drive shaft frequency nonlinear adaptive control design

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Power systems for mobile objects are very essential in providing desired motion; object survivability and ability to realize the objectives is directly depended to power systems efficiency. In the report we explore synergetics approach to vessel drive shaft frequency nonlinear adaptive control design. This approach is based on synergetics concept of unity of directed self-organization and control.
We present computer simulation results as well as comparison of built synergetics regulator with classic vessel turbine drive shaft rotation frequency control (according presented in [2]).
Keywords: ship's turbine, synergetics control, integral adaptation, attractor - invariant.

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Chaos and intermittency in penetrative convection

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We considered a fluid confined in a horizontal infinite plain layer with quadratic dependency of density on temperature. Water at atmospheric density and temperature from 0C to 10C with the density maximum about 3.98C can be considered such a fluid with acceptable reliability. The upper and lower boundaries are held at constant temperatures, such that 4C is in the range. We investigate development of convective instability. It is known that for the equal heights of stable and unstable layers the instability of steady solution is subcritical, the flow from unstable layer spreads to the whole layer and the stable layer reveals itself through small countervortices in the upper layer. We showed that most realizable transition to chaos occurs through sequence of periodic motion, then doubling of period, then quasioperiodic motion with torus in phase space, and finally chaotic motion with strong intermittency unlike classical or double-diffusive convection. At the same time there are several other solutions depending on initial data and branches of hysteresis were investigated. For penetrative convection nonlinear influence on horizontal wavelength is more important than it is in classical convection so we carefully investigated what size of convective cell to choose for studying transitional processes. Stability and structure of attractors were shown with the help of Poincare sections. Study of structure of the chaotic attractors is more complicated since there was no "steady" chaotic motion, but with bursts of intermittency in orthogonal direction.
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Studying the Non-Linearity of Tumour Cell Populations under Chemotherapeutic Drug Influence

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Biological systems are characterized by their potential for dynamic adaptation. Such systems, whose properties depend on their initial conditions and response over time, are expected to manifest non-linear behaviour. In a previous work we examined the oscillatory pattern exhibited by leukemic cells under *in vitro* growth conditions, where the system was simulating the dynamics of growth with disease progression. Our question in the previous study evolved around the nature of the dynamics of a cell population that grows, or even

struggles to grow, under treatment with chemotherapeutic agents. We mentioned several tools that could become useful in answering that question, as for example the *in vitro* models which provide information over the spatio-temporal nature of such dynamics, but *in vivo* models could prove useful too.
In the present work we have studied the non-linear effects that arise from cell population dynamics during chemotherapy. The study was performed not only in the sense of cell populations *per se* but also as an attempt of identifying sub-populations of cells, such as apoptotic cells and cells distributed within the cell cycle. The temporal transition from one state to the next was revealed to follow non-linear dynamics. We have managed to approximate the non-linear factor that influences these temporal space transitions. To the best of our knowledge there are not many studies dealing with this topic, which makes it even more interesting. Such approaches could become very useful in understanding the nature of cell proliferation and the role that certain chemotherapeutic drugs play in cell growth, with emphasis given on the underlying drug resistance and cell differentiation mechanisms.
Keywords: Proliferation, oscillations, non-linearity, CCRF-CEM, glucocorticoids.

Clustering in ergodic processes: the law of series

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The law of series in ergodic theory comes out as an interpretation of a surprising phenomenon appearing in ergodic processes presenting positive entropy, and discovered in 2006. This phenomenon is connected to the theory of asymptotics of return times to long cylinder sets in ergodic symbolic processes, that is weak convergence of normalized distribution functions for return times to typical cylinder sets.
For fast enough mixing systems sevral studies have proven that mixing grants that the distributionnal behaviour of entry or return times to those cylinders is approximately exponential with parameter 1, but not much was known earlier about other possible behaviours in generic processes, or arbitrary processes presenting a chaotic behaviour in some sense (positive entropy).
We came to prove that for chaotic systems the asymptotic distribution for entry times cannot exceed the exponential law with parameter 1, and moreover that typically for such a process a partition generates a symbolic factor for which the distribution is ultimately degenerate (equals zero in fact !). This extends to zero entropy processes and also supports approximate returns in a d-bar metric sense.
A simple argument using preservation of measure shows how this connects to the appearence of clusters of rare events, which somehow gives a first interpretation for the law of series in this very general and simple mathematical model, contrary to the interpretation of Warren Weaver.

Dynamics of the electromechanical system with impact element

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The main aim of the paper is to focus on analysis of a dynamical properties of the EM model. The EM model, electromechanical system with impact element, is constructed with three degree of freedom in mechanical oscillating part, two translational and one rotational. The mathematical model of the system is represented by three coupled second-order ordinary differential equations in dimensionless form. Here, the most important nonlinearities are: stiffness of both (drive and work) spring elements and rotor movement supported by the eccentricity.
Keywords: mechanical oscillations, impacts, chaotic behavior

Chaotic dynamics of a biaxial anisotropic magnetic particle

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In the present work we study the deterministic spin dynamics of a biaxial anisotropic magnetic particle in the presence of a magnetic field with a constant longitudinal and a time dependent transverse component using the Landau-Lifshitz equation. We characterize the dynamical behavior of the system by monitoring the Lyapunov exponents. In particular, we explore the dependence of the positivity of the largest Lyapunov exponent on the magnitude and frequency of the applied magnetic field and its direction with respect to the anisotropy axes of the magnetic particle. We have found that the system presents multiple transitions between regular and chaotic behavior. In parameter space there is complicated topology of intricately intermingled chaotic and regular regions, whose boundaries are not fractal but rather fuzzy.

Taxonomic identification of foraminifers for oil reservoir in diffusion-limit growth of seashore at Campeche, Mexico

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The physic statistical of sedimentary rocks will allow us the identification and classification of diffusion-limited growth of oil reservoirs in which modern's concepts of random systems as fractals and percolation where the pictures are performed with tunneling electronic (TEM) and atomic force (AFM) microscopy. Such methodology [1] can be use for taxonomic identification of foraminifers and

their distribution in the sandstone, which are of particular significance for oil reservoir [2]. Usually, the proportion of them is important to take them on count for fractal parameter dimension, and in consideration of their size is similar in magnitude of single sandstone it would be very important to determinate the influence of this organism protozoa in the chemical, biological and physical properties related to the oil reservoir.
Keywords: foraminifers, oil reservoir, fractal dimention parameter

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Decoding of atmospheric pressure plasma emission signals for process control

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Low-temperature, non-thermal atmospheric pressure plasmas (APP) are being developed for surface treatment of biomedical devices, sterilisation, and therapeutic techniques, such as wound sterilisation and cancer treatment. In addition to these medical applications, APP are now routinely employed in the automotive (car head lamps) and aerospace (fuselage and wing components) industry for surface activation of polymer prior to bonding. The impact of this technology offers enhanced quality of care at reduced cost and will be of immense societal and commercial value.
The invited plenary talk shall focus on the emerging plasma optical and electro-acoustic metrology that is being developed for these atmospheric pressure plasmas. In particular the requirement for extraction of information that describes the tempo-spatial heterogeneous processes, presently this technology is in its infancy when compared to low pressure plasma metrology. The new metrology multivariate analysis tools for the deconvolution and compression of single observables such as time-vary electrical current and electro-acoustic signals are presented for three different and contrasting plasma processes. The APP metrology will pertain to: the hand held plasma jet (needle) [1] reel-to reel APP [2, and 3], and CNC controlled plasma jets [4, and 5].
Keywords: plasma, electrical harmonics, acoustic overtones, acoustic impedance

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Chaotic ionization of planar helium

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Enormous progress has been made towards giving a full quantum description of two-electron atoms over the whole energy range. The bound-state spectrum and the structure of low-lying doubly excited resonances is now well understood. Likewise, for energies above the three-particle break-up threshold, very efficient numerical methods are now available, and these make it possible to give detailed numerical predictions for photoionization cross sections from energies above the double-ionization threshold (E=0) ranging from near the threshold all the way to the high-energy end of the double ionization continuum. There is, however, still a considerable gap in our knowledge of the quantum dynamics of two-electron atoms in the energy range of highly-doubly excited resonances below the double-ionization threshold. Recent experimental progress in detector technology and synchrotron sources has made it possible to get fully resolved single ionization spectra up to N□15 both for partial and total photoionization cross sections. Here, the quantum number N refers to the hydrogen-like state of the remaining ion with energy -Z^2/2N, where Z is the nuclear charge. Numerical efforts for calculating the photo-ionization cross section have advanced slowly reaching now up to N=17; progress is hampered here by the fast increase in basis size necessary to achieve convergence for increasing N values. The numerical results clearly show a selective breakdown of labeling individual resonances in terms of approximate quantum numbers; a lot of important questions remain open, however, such as whether approximate symmetries persist when approaching the double ionization threshold from below. The rich resonance spectrum for energies E<0 is intricately linked to the

complexity of the underlying classical dynamics of this three-body Coulomb problem. The classical dynamics is mostly chaotic in this energy regime which is reflected in the statistical properties of the resonance spectrum. The dynamics in various two dimensional subspaces has be en studied in detail; a global description, which can, for example, explain the existence of approximate quantum numbers from a semiclassical point of view is, however, still in its infancy. The chaotic part of the classical dynamics, on the other hand, is dominated by the complex folding patterns of the stable/unstable manifolds of the triple collision which has been analyzed in detail by few groups. A semiclassical description of photoionization cross sections for two-electron atoms taking into account the nature of the triple collision has been worked out for total and partial cross. In particular, it was demonstrated for the collinear eZe helium model that the fluctuations in the total and partial cross section due to doubly excited states decays algebraically with an exponent determined by the triple collision singularity different from Wannier's exponent. Furthermore, the fluctuations can be described in terms of contributions from closed orbits starting and ending in the triple collision - so-called closed triple collision orbits. We extend our numerical method to two-electron atoms in a plane. Results of quantum calculation for planar helium show behavior of the total photoionization cross section as a function of the energy consistent with our theoretical predictions based on a semiclassical approach. Underlying classical dynamics of two-electron atoms in a plane is also investigated for understanding the characteristics of the total photoionization cross section, especially for the stability behavior in the Wanner Ridge space.

Extended betas leading to extreme value stable models, and their chaotic behaviour

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Positive power functions model exponential growth, and positive powers of the absolute value of the logarithmic function are slowly varying, both at zero and at infinity. We discuss the use of the product those functions — thus generalizing the beta densities — to characterize sophisticated forms of equilibrium in the growth of natural populations, when the reproductive impetus is counteracted by a negative retroaction, due to the limitation of resources, for instance insufficient oxygenation of the inner cells of neoplastic tumours. While the logistic parabola rx(1-x) generates the Verhults model of sustainable, the simpler case c x ln x of this general class generates the Gumbel (i.e., a stable extreme value) model of growth, known in population studies by Gompertz function.In previous works, the authors in [1], [2], [3], and [5], investigated fractality associated with Beta(p, q) models, and introduced a new family Beta*(p, q) of probability density functions, further extended in [4]. These lead to more general differential equations for the population growth, whose solutions are the extreme value stable models. In this work, we analyse the complex

dynamical behaviour of these models in a parameter space, in terms of topological entropy.
Keywords: signed mixtures of beta densities, power laws, Gompertz growth model and Gumbel law, extreme value laws, growth models.

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Wavelet-based Forecasting of Chaotic Time Series

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Chaos may be present in economic time series (Hommes and Manzan, 2006) and several tests have been proposed, including the BDS-test by Brock et al (1996) which is based on the correlation integral. However, the estimation of the correlation dimension is not easy to achieve, especially when the dimension of the system increases. Moreover, it is extremely difficult to distinguish between high dimensional chaos and randomness unless the time series is very long. The inadequacy of current estimation techniques to deal with chaos in time series may be the reason why despite elaborate forecasting models, forecasters cannot anticipate financial crisis, such as the Asian financial crisis and the recent US sub-prime market crisis. This paper is an attempt to harness the wavelet technology to develop an approach that can deal with chaos in time series forecasting. The approach can be implemented in a software or embedded within applications to allow for real time online estimation and forecasting of time series with chaos.
Keywords: chaos in time series, forecasting, wavelets

Chaos in a simply formulated dry-friction oscillator

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Chaotic oscillators with Coulomb-type friction were extensively studied in the past. However, these investigations mostly deal with rather complex mechanical models that are closely related to everyday's engineering applications. In the present paper we introduce a stick-slip oscillator consisting only of a spring and a block sliding on a rough surface and the block is periodically forced. A simple friction law is implemented in which we consider sticking and sliding coefficients of friction. We show with the help of numerical simulation that the system can behave chaotically in certain parameter domains. We use common numerical techniques to visualize chaos and also try to estimate the value of the maximal Lyapunov exponent. We also point out the possibility of transient chaos by means of cobweb diagrams.
Keywords: dry-friction, stick-slip, forced oscillator, transient chaos

The Onset of Turbulence in a Spatiotemporally Chaotic System

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We show the existence of two-state on-off intermittent behavior in spatially extended dynamical systems, using as an example the damped and forced drift wave equation. The two states are stationary solutions corresponding to different wave energies. In the language of (Fourier-mode) phase space these states are embedded in two invariant manifolds that become transversely unstable in the regime where two-state on-off intermittency sets in. The distribution of laminar duration sizes is compatible with the similar phenomenon occurring in time only in the presence of noise. In an extended system the noisy effect is provided by the spatial modes excited by the perturbation. We show that this intermittency is a precursor of the onset of strong turbulence in the system.

Application of Chaos and Complexity Models in Sustainable Building Simulation

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This paper intends to provide suggestions of how sustainable building simulation might profit from mathematical models derived from chaos theory. It

notes that with the increasing complexity of sustainable building systems which are capable of intelligently adjusting buildings' performance from the environment and occupant behaviour and adapting to environmental extremes, building performance simulation is becoming more crucial and heading towards new challenges, dimensions, and concepts and theories beyond the traditional ones. The paper then goes on to describe how chaos theory has been applied in modelling building systems and behaviour, and to identify the paucity of literature and the need for a suitable methodology of linking chaos theory to mathematical models in building sustainable studies. Chaotic models are proposed thereafter for modelling energy consumption, nonlinear moisture diffusion, and building material properties in building simulation. This paper provides an update on the current simulation models for sustainable buildings.

Keywords: Chaos theory, Sustainable building simulation, Energy consumption, Moisture diffusion

Application of Fractal Geometry in Architectural Design

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The idea of building in harmony with nature can be traced back to ancient Egyptians, China, Greeks and Romans. As the language of nature, it is, therefore, natural to assume that fractal geometry could play a role in developing new forms of aesthetics and sustainable architecture and building design. Fractal dimensions present orders in patterns which can be used to identify the hidden orders in the apparently random patterns. Order in irregular pattern is important in aesthetics as it embraces the concept of dynamic force, which shows a natural phenomenon rather than mechanical process. In architecture design terms, it represents design principle. This paper presents illustrative review of some fractal case studies in architectural design and introduces fractals as new concepts to understand the dynamic organization of the architectural design patterns. The paper shows that incorporating the fractal way of thinking into the analysis of the architecture design provides a language for an in-depth understanding of complex nature of architectural design patterns in general. This study distills the fundamental properties and the most relevant characteristics of Fractal geometry essential to architects and building scientists, initiates a dialogue and builds bridges between scientists and engineers, and stimulates future research about a wide range of issues on building architectural design.

Keywords: Fractal geometry, Architecture design, Sustainability

The Multiple Scales Method for the Analysis of a Double-Zero/Single-Hopf Bifurcation

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An interesting problem related to three-parameter families of autonomous, nonlinear dynamical systems, is the simultaneous occurrence of a double-zero and a single Hopf bifurcation, which does not seem to have received attention in the literature, yet. The interest in this codimension-3 bifurcation is stimulated by the fact that self-excited quasi-Hamiltonian systems can experience codimension-2 simple-zero/Hopf bifurcation: in this case the critical eigenvalues of the Jacobian matrix are $\lambda c = (0,\pm i\omega)$; if however the damping ξ is small, a fourth stable eigenvalue $\lambda s = -\xi < 0$ is close to the imaginary axis, leaving ambiguous how to tackle this bifurcation. Here a nonstandard version of the Multiple Scales Method is implemented to get the bifurcation equations for a 2 d.o.f. systems experiencing double-zero/single-Hopf bifurcation; then, the regions corresponding to qualitative different behavior are drawn in the parameters space.
Keywords: Multiple Scales Method, double zero bifurcation, Hopf bifurcation, codimension 3 bifurcation.

A Numerical Study on the Effect of Injection Velocity on Fuel Droplets Sizing in a Three-Dimensional Side-Dump Combustor

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The effects of injection velocity on propulsive droplets sizing and efficient mass fraction in a three dimensional side-dump combustor with dual opposite curved side-inlet duct are numerically investigated in the present paper. The mass of fuel vapor inside the flammability limit is named efficient mass fraction. The air flow comes from side-inlet ducts into the cylindrical combustor and two nozzles which are located in the top of the cylinder have the duty of fuel injection. The injectin velocity is varied as 30, 35, 40, 45, 50, 65 and 60 (m/s) to examine its effects on propulsive droplets sizing and efficient mass fraction which provides worthwhile information for the combustor design work. To fulfill the calculations a modified version of KIVA-3V code which is a transient, three-dimensional, multiphase, multicomponent code for the analysis of chemically reacting flows with sprays, is used.
Keywords: Droplet sizing, efficient mass fraction, side-dump combustor, injection velocity

Fractality as a modern concept of synergetics

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To date, the concept of "fractal" has firmly entered the lexicon of synergistic thesaurus. Fractality as a concept of modern synergy allows us to consider being in terms of scale invariance or self-similarity of the elements. The concept of fractal fits in a synergistic discourse, introducing the concept of a heuristic description of complex nonlinear systems of any nature (including social).
Keywords: synergetics, fractals, socio-humanitarian knowledge

2D Erupting Solitons in Dissipative Media

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Using a Fourier spectral method we have found symmetric soliton eruptions in weakly nonlinear behavior of dissipative systems modeled by the two-dimensional complex cubic-quintic Ginzburg-Landau equation. We explain the eruptions based on a linear stability analysis, and show how the erupting soliton can be viewed as a strange attractor.
Key words dissipative solitons, Ginzburg-Landau equation, solitons, exploding, errupting, dissipative media

Symmetry-Breaking of Interfacial Polygonal Patterns and Synchronization of Traveling Waves within a Hollow-Core Vortex

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A hollow vortex core in shallow liquid, produced inside a cylindrical reservoir using a rotating disk near the bottom of the container, exhibits interfacial polygonal patterns. These pattern formations are to some extent similar to those observed in some geophysical, astrophysical and industrial flows. In this study, the dynamics of rotating waves and polygonal patterns of symmetry-breaking generated in a laboratory model by rotating a flat disc near the bottom of a cylindrical tank is investigated experimentally. The goal of this paper is to describe in detail and confirm previous conjecture on the generality of

the transition process between polygonal patterns of the hollow vortex core under shallow water conditions. Based on the image processing and an analytical approach using power spectral analysis, we generalize in this work – using systematically different initial conditions of the working fluids such as fluid viscosity – that the transition from any *N-gon* to *(N+1)-gon* pattern observed within a hollow-core vortex of shallow rotating flows occurs in an universal two-step route: a quasi-periodic phase followed by frequency locking (synchronization). The present results also demonstrate, for the first time, that all possible experimentally-observed transitions from *N*-gon into (*N*+1)-gon occur when the frequencies corresponding to *N* and *N*+1 waves lock at a ratio of (*N*-1)/*N*.
Keywords: Swirling flow; patterns; transition; quasi-periodic; synchronization

Innovation From Chaos: Emergent Contradictions, Triz And Complex Systems Theory

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Innovation comes from resolved conflicts and contradictions. Innovation opportunities thus arise by uncovering such contradictions. Sometimes this is readily achieved, but oftentimes – especially in complex systems – it is not. The paper focuses on the identification and resolution of conflicts and contradictions in complex systems as the start of the innovation journey. By constructing simple, computer-based bottom-up models of an exemplar complex system, we show the potential for the emergence of multi-phase macro-level outcomes. We then show how these discontinuous phase-shifts may be modelled as contradictions, and from there, how TRIZ tools can be used to generate innovative solutions.
Keywords: complexity, emergence, phase-shift, discontinuity, bottom-up

The Influence of Charge Traps in Semiconductor Diode on Complex Dynamics in Non-autonomous RL-Diode Circuit

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In this work the results of numerical simulation of the complex charge dynamics in the well known model system - p-n junction semiconductor diode connected with non-autonomous RL-diode circuit are presented. Nonlinear charge dynamics was shown as changes of the oscillation regimes maps topology in the presence of charge traps in diode and without ones. The effects under consideration were explained on the base of detailed description of p-n junction functioning in terms of accumulation and relaxation of non-equilibrium charge carriers at diode base. As well, the study of the influence of the charge accumulation and recombination processes on the traps on excitation of complex current oscillations in the circuit was carried out.

We discuss the possibility the application of the comparative analysis of oscillation regimes maps topology as a method for express traps diagnostics in semiconductor devices.

Keywords: p-n junction, semiconductor diode, complex oscillations, numerical simulation, charge traps, non-equilibrium charge carriers.

Simple Phenomenological Model of Complex Oscillations in Metal-Working

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The dynamical factors such as elastic deflection of technological system under the action of cutting force exert significant influence on part feature accuracy. Usually it is difficult to carry out application investigation. It leads to the necessity of construction numerical models based on partial derivative equations, non-autonomous ordinary differential equations (ODEs) etc. It makes possible to identify states areas of technological system in the control parameters space and its behavior under various model properties.

Analysis of some works devoted to dynamic simulation of technological systems has shown that they are overloaded with complicated dynamical models which include subtle interaction effects between the workpiece and cutting tool. As a rule, considerable simplifications are permitted in the process of model construction. These complicated models are used in special integrated software environments for simulation modeling. It can lead to the considerable limitations in the choice of methods of predicted response analysis and serious calculation inaccuracy. Furthermore, it's impossible to use efficiently research methods common for modern theory of nonlinear dynamical systems. It is known that complex dynamics often appears in simple systems and models. These simple models proved to be sufficiently accurate for physically correct description of complex dynamical phenomena.

The present work contains simple phenomenological model of complex oscillating motion in metal cutting system. The model represents a system of non-autonomous ODEs. Zero lag appears to be a distinctive feature of this model.

Keywords: technological system, complex oscillations, complex dynamics, metal cutting, metal-working, elastic deflection, phenomenological model

"Structures" of deterministic chaos

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By modeling the Bray-Liebhafsky reaction (the hydrogen peroxide decomposition in the presence of hydrogen and iodate ions) we have found regular "structures" of the deterministic chaos. The forms, types and evolution of

these structures resemble those obtained in the periodic dynamic states. Namely, between each successive mixed-mode dynamic states, always the same transition scenario is found when the control parameter (flow rate in a continuously fed well-stirred tank reactor) is increased. That is, the initial dynamic state transforms to the next one by period doubling, chaos and periodic mixture of different mixed-mode oscillations. However, between any successive periodic states, chaos of analogous structures is found. Thus, we were able to recognize and qualitatively and quantitatively distinguish the “period doubling” chaos and the chaos that consisted of periodic mixed mode oscillations. Additionally, between them, the chaos without recognizable “structures” was observed.
Keywords: structures of chaos, period doubling, mixed mode oscillations, Bray-Liebhafsky oscillatory reaction.

Particle based method for shallow landslides: modeling sliding surface lubrication by rainfall

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Landslides are a recurrent phenomenon in many regions of Italy: in particular, the rain-induced shallow landslides represent a large percentage of this type of phenomenon, responsible of human life loss, destruction of assets and infrastructure and other major economical losses. In this paper a theoretical computational mesoscopic model based on interacting particles has been developed to describe the features of a granular material along a slope. We use a Lagrangian method similar to molecular dynamic (MD) for the computation of the movement of particles after and during a rainfall. In order to model frictional forces, the MD method is complemented by additional conditions: the forces acting on a particle can cause its displacement if they exceed the static friction between them and the slope surface, based on the failure criterion of Mohr-Coulomb, and if the resulting speed is larger that a given threshold. Preliminary results are very satisfactory; in our simulations emerging phenomena such as fractures and detachments can be observed. In particular, the model reproduces well the energy and time distribution of avalanches, analogous to the observed Gutenberg-Richter and Omori distributions for earthquakes. These power laws are in general considered the signature of self-organizing phenomena. As in other models, this self organization is related to a large separation of time scales between rain events and landslide movements. The main advantage of these particle methods is given by the capability of following the trajectory of a single particle, possibly identifying its dynamical properties.
Keywords: Landslide, molecular dynamics, lagrangian modelling, particle based method, power law.

An Extended Stochastic Quadratic Model for Modeling Survival Data

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In this paper we present a stochastic model (Extended Quadratic Model) and we estimate the Function of Population Health State. We analyze the survival data of two European countries during the ages. Especially we analyze the local maximum and minimum of age distribution of mortality and we portray them in graphs. Afterwards we introduce methods to model the survival data.
Finally, we model the data with different dynamic models, we estimate the parameters of the models, accomplish stochastic simulation and present stochastic paths while we fit the data with deterministic Weibull model. We provide graphs and make comparisons between models.
Keywords: Stochastic models, Extended Quadratic model, Weibull model, Survival data, Survival modeling

Life table data analysis using dynamic and deterministic models

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We present and analyze the survival data of some European and non-European countries in the time course. At the beginning we introduce some demographic elements separately for each country and at the same time we study the different characteristics of mortality between the two sexes. We draw important conclusions about the different characteristics of mortality between male and female population and show indicators about the increase of the average life and the variation of infant mortality. We provide graphs and make comparisons between four different ways of modeling by using stochastic and deterministic models.
Keywords: Survival analysis, Life table data, Mortality, Stochastic modeling

Metriplectic Framework for the Visco-resistive Magneto-Hydrodynamics

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After the appearance in Physics of the Action Principles, and the introduction of the Hamiltonian framework, scientists have appreciated the great potentiality of turning dynamical systems into bracket algebræ of observables.
Conservative systems are traditionally represented as Hamiltonian systems, i.e. a conserved observable H and a Poisson bracket algebra [□,□] are defined, so that the motion of any physical quantity Q is symplectically generated by

calculating [Q,H]. This scheme has greatly clarified the roles of symmetries in Physics, and has introduced a straightforward quantization rule on which a large part of the Modern Physics is based.
Turning dissipative dynamical systems into bracket algebræ is a more recent achievement: in particular here the metriplectic approach to this problem is considered. Essentially, the dynamics is subdivided into a symplectic (i.e. Hamiltonian, "conservative") component, still generated by some Hamiltonian through some Poisson bracket, plus a metric component, that gives rise to dissipation terms and is generated, through a new symmetric bracket (□,□), by a certain symplectically-invariant quantity C. This C is related to the entropy of those "internal" degrees of freedom, not explicitly described by the dynamical variables of the system, towards which dissipation drains the energy.
In this paper, the metriplectic framework is applied to the dissipative Magneto-Hydrodynamics (MHD), adapting what had already been done for the non-idead Hydrodynamics (HD).
The result is obtained by extending the HD symmetric bracket to include the magnetic field, so that the correct motion is generated once C is identified with the total thermodynamical entropy of the plasma. Then, it is shown that the metriplectic framework of the MHD is invariant under the action of the Galileo Group.

Algebrizing friction: a brief look at the Metriplectic Formalism

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The formulation of Action Principles in Physics, and the introduction of the Hamiltonian framework, reduced dynamics to bracket algebræ of observables. Such a framework has great potentialities, to understand the role of symmetries, or to give rise to the quantization rule of modern microscopic Physics.
Conservative systems are easily algebrized via the Hamiltonian dynamics: a conserved observable *H* generates the variation of any quantity *f* via the Poisson bracket {*f*,*H*}.
Recently, dissipative dynamical systems have been algebrized in the scheme presented here, referred to as *metriplectic framework*: the dynamics of an isolated system with dissipation is regarded as the sum of a Hamiltonian component, generated by *H* via a Poisson bracket algebra; plus dissipation terms, produced by a certain quantity *S* via a new symmetric bracket. This *S* is in involution with any other observable and is interpreted as the *entropy* of those degrees of freedom statistically encoded in friction.
In the present paper, the metriplectic framework is shown for two original “textbook” examples. Then, dissipative Magneto-Hydrodynamics (MHD), a theory of major use in many space physics and nuclear fusion applications, is reformulated in metriplectic terms.
Keywords: Dissipative systems, Hamiltonian systems, Magneto-Hydrodynamics.

On the Existence and Stability of Periodic Motions in Harmonically Excited Vibro-Impact Systems

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This works presents the modeling and some analysis of a base harmonically excited vibro-impact system. The system have been studied by several researchers who exploited many aspects of the dynamics overall. However, they have supposed only one pattern of periodic motions, that is, a motion with the same period as the excitation force. This work shows that several patterns of periodic motions can occur and the existence and stability conditions of them should be studied accurately. Periodicity conditions are applied over the state at the instants of impacts in order to obtain a map of the next impact based on the state at earlier one. This nonlinear map is applied to obtain the conditions of existence of periodic motions with specific patterns. Applying the existence conditions, the stability of the motion can be carried out by analyzing the eingenvalues of the linearized map taking those conditions into account. Some very interesting results were obtained, for example: It is always possible to set initial conditions for which a periodic motion with the same period of the excitation and two collisions per period occurs.
Keywords: nonlinear oscillations, vibro-impact, periodic motions, bifurcations, stability

Fractal Market Time

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The no arbitrage condition requires that market returns are martingale and the existence of long range dependence in the squared and absolute value of market returns (Granger et al. [9]) is consistent with Fractal Activity Time (Heyde [12]). We model the market clock as the integrated intensity of a Cox point process of the transaction count of stocks traded on the New York Stock Exchange (NYSE).
A comparative empirical analysis of a self-normalized version of the integrated intensity is consistent with a fractal market clock with a Hurst exponent of 0.75.
Keywords: Time Deformation, Long Range Dependent, Stochastic Clock, Fractal Activity Time, New York Stock Exchange, Doubly Stochastic Binomial Point Process.

Non-linear Process and Metaphor in Experimental Music

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New approaches to dynamic rather than static representation of Chaos in musical composition.

Non-linearity and chaos are exciting ideas for composers in many ways. Music is essentially patterns of repetition and variation over time, and much of musical structure and meaning is predicated on the ambiguities of tension and release. Non-linear systems such as strange attractors hover between variation and repetition, defining a structure gradually over time.

The generation of composers active when Chaos Theory was first popularised adopted it largely from a mimetic perspective, where the objects and structures of chaos theory are used to inform the composition of linear musical structures. Pieces such as Tristan Murail's Attracteurs étranges (1992) use the strange attractor as a 'poetic analogy' [1] for its oscillating cello line, while in Rolf Wallin's Onda di Ghiaccio (1989) fractal equations are applied to the musical materials to 'describe the dynamics of every turbulent process',[2] but still resulting in a linear and mimetic representation of this process. The application of processes here are compositional.

The paradigm of indeterminacy, as used in Experimental Music, is demonstrably non-linear in a musical context: either as compositional process (such as Cage's chance procedures) or as a performance-based process (in the music of Christian Wolff, Cornelius Cardew, et al). The non-linear structures of strange attractors and other chaotic structures can be applied to indeterministic musical process to move beyond the linear paradigm of static musical structures into the realm of dynamic structures and material.

John Cage describes a goal of art as to 'imitate nature in the manner of her operation […] changes in science give artists different understandings of how nature works'.[3] What I propose is a form of anti-mimesis, where the process is translated from the mathematical to the musical/performative, retaining the mechanics but in a new medium. I will present examples from on my own music and others, showing how feedback and hysterisis are used to create musical processes that afford non-linear and emergent sound structures. This approach to the structures and ideas of Chaos/complex mechanics allows for dynamic musical structures that respond to the non-linearities of performance.

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Study For A Mechanism Aided By Asynchronous Actuator Powered By Asynchronous Diesel Generator

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The modern electric facilities are equipped by a great number of different mechanisms and devices actioned by Asynchronous electric Motor (ASM), the power of these motors is equal to the power of the generating devices, where their most complicated working regime is the starting when their power is equal to the power of the generating devices.
In this regime we can have an overcharge of the generating devices by the active and reactive power.
For this reason, this article is dedicated to the study of the starting methods of asynchronous motors that action the mechanisms and that are powered by Asynchronous Generating Diesel (AGD) with a limited capacity of DRY value and a given couple of resistance.
Keywords: Reliability, Autonomous asynchronous generator, starting of the asynchronous motors, Tention converter.

A study of seismicity chaotic behavior under powerful electromagnetic action

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A study of strong EM pulse actions on seismic regime in the region of Bishkek test site, Kyrgyzstan, is made with the help of Grassberger-Procaccia method of correlation integral calculation for different embedding space dimensions. It is supposed, that if any change in seismic regime regularities occurs due to EM actions, it will be reflected in corresponding dynamic system parameters at least. A catalog of earthquakes obtained by KNET seismic network was used for the analysis. The catalog included data on 6623 earthquakes with magnitudes from 0.5 to 6 registered since 01.06,1994 to 30.12.2008.
The considered area of possible EM excitation influence was 200x200 km in size with center coincident with EM source position. The earthquake catalog was divided into two parts of the same durations: before EM excitations and during the excitations. Seismic activity was calculated as sum of cubic roots from energies of seismic events occurred during a week (3 days overlap of the time intervals was used). The study of the seismic activity variations was made by means of the phase portrait reconstructions and calculations of the portrait parameters (an embedding space dimensionality and correlation dimension of an attractor, if that one exists). Parameters of time delay were chosen on the base of autocorrelation functions.
The obtained results show an increase of seismic regime regularity after beginning of EM pulses action: before EM excitation, the correlation

dimensionality of the possible attractor was not less than 8 with corresponding embedded space dimension 14. After start of EM excitations, the attractor correlation dimensionality diminished to 4.6, embedded space dimension – to 6. The model of possible reaction of the geomechanical system governed by rate-and-state friction law on perturbations due to EM actions is considered numerically. It is shown, that small change of fault and fracture strengths under EM action leads to diminishing of attractor and embedded space dimensions.

Control of a Weakly Damped Oscillating Parafoil Payload System using Non-Linear Dynamic Inversion

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A Parafoil is an anhedral wing made of a flexible material usually a fabric which facilitates its use as a parachute. These are better than traditional (round canopy) parachutes because unlike the round canopy parachutes they produce not only drag but also lift[1]. This adds a great deal of maneuverability to the Parafoil making it much more desirable for a variety of civil as well as defense applications. A parafoil as compared to a conventional flight vehicle has a few marked differences. Firstly, a parafoil does not have any thrust producing system of its own, which makes it highly susceptible to wind gusts. Second, unlike a traditional vehicle, a parafoil has only 2 control surfaces namely the flaps on either side of the wing. It does not have any vertical tail. Since the control line is made up of strings, the flaps can only be pulled down and not pushed up. The steer-ability of the parafoil is due to the flaps which can be deflected either symmetrically or unsymmetrically causing it to brake or turn respectively. The parafoil is extensively used for defense purposes such as delivery of personnel or equipment at locations where landing and take-off is difficult.

Parafoil being a highly maneuverable vehicle, a control law is of prime importance so as to make the maximum use of it. The control law can be used to take the parafoil form a current state „A to a desired state „B. It can essentially make the Parafoil an autonomous vehicle which can be guided to a desired location without any human interface. This particular feature will be of a great value especially in defense related applications where a payload needs to be dropped at a specific location. Once the Parafoil is autonomous, all one needs to do is give the desired landing location and the control law will generate the surface deflections. Also the control law needs to be apt at handling non-linarites because the Parafoil itself is a non-rigid body coupled with the wind conditions which are highly non-linear.

Non-linear dynamic inversion (NDI) is a control methodology useful for systems where linear approximations do not hold true. It can be applied in time domain as well as frequency domain. Time domain approach involves continuous control by inverting the dynamics of the system at every instant. Frequency domain involves linearization of the system around a fixed point which is suitably chosen from the flight envelope. The key feature of this approach is that it incorporates all the non-linarites of the system as against a conventional control law which mostly linearizes the system, thereby making NDI more robust and reliable under extreme conditions. Also NDI is more preferred as it can handle wind instabilities

with relative ease. It is a highly emerging control domain area and has been applied to several flight vehicles [2],[3].

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Biological Growth In The Fractal Space-Time With Temporal Fractal Dimension

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In the biological systems the fractal structure of space in which cells interact and differentiate is essential for their self-organization and emergence of the hierarchical network of multiple cross-interacting cells, sensitive to external and internal conditions. Hence, the biological phenomena take place in the space whose dimensions are not represented only by integer numbers (1,2,3 etc.) of Euclidean space. In particular malignant tumors and neuronal cells grow in a space with noninteger fractal dimension. Since, cellular systems grow not only in space but also in time, an idea has been developed that the growth curves representing neuronal differentiation [1] or malignant tumor progression [2] can be successfully fitted by the temporal fractal function

$$y(t) = a_t t^{b_t} \qquad t > 0$$

in which y(t) characterizes the time-evolution of the system, b_t is its temporal fractal dimension whereas a_t - a scaling factor. One may prove [1,2] that in the case of biological systems whose growth is described by the Gompertz function

$$G(t) = G_0 e^{\frac{b}{a}\left(1-e^{-at}\right)}$$

temporal fractal dimension and scaling factor are time-dependent functions $b_t(t)$ and $a_t(t)$, which permit calculation their values at an arbitrary moment of time or their mean values at an arbitrary time-interval. The analytical expressions take the form

$$b_t(t) = bte^{-at}\frac{e^{\frac{b}{a}\left(1-e^{-at}\right)}}{e^{\frac{b}{a}\left(1-e^{-at}\right)}-1} \qquad a_t(t) = t^{-b_t}\left[e^{\frac{b}{a}\left(1-e^{-at}\right)}-1\right]$$

The model proposed has been applied to determine the temporal fractal dimension of the tumor growth and synapse formation as qualitatively these processes are described by the same Gompertz function. The results obtained permit formulation of two interesting rules:

(i) each system of interacting cells within a growing system possesses its own, local intrasystemic fractal time, which differs from the linear (b_t=1) scalar time of the extrasystemic observer;

(ii) fractal structure of space-time in which biological growth occurs, is lost during progression.

It will be proved that the fractal function y(t) is a special case solution of the quantal annihilation operator for the space-like, minimum-uncertainty coherent states of the time-dependent Kratzer-Fues oscillator. Such states propagate along the well defined time trajectory being coherent in space. Hence, the biological growth in the space-time with temporal fractal dimension is predicted to be coherent in space.

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Adaptive control of the singularly perturbed chaotic systems based on the scale time estimation by keeping chaotic property

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In this paper, a new approach to the problem of stabilizing a chaotic system is presented. In this regard, stabilization is done by sustaining chaotic properties of the system. Sustaining the chaotic properties has been mentioned to be of importance in some areas such as biological systems.

The problem of stabilizing a chaotic singularly perturbed system will be addressed and a solution will be proposed based on the OGY (Ott, Grebogi and Yorke) methodology. For the OGY control, Poincare section of the system is

defined on its slow manifold. The multi-time scale property of the singularly perturbed system is exploited to control the Poincare map with the slow scale time. Slow scale time is adaptively estimated using a parameter estimation technique. Control with slow time scale circumvents the need to observe the states. With this strategy, the system remains chaotic and chaos identification is possible with online calculation of lyapunov exponents.
Using this strategy on ecological system improves their control in three aspects. First that for ecological systems sustaining the dynamical property is important to survival of them. Second it removes the necessity of insertion of control action in each sample time. And third it introduces the sufficient time for census.
Keywords: OGY, lyapunov exponent, slow manifold, adaptive, singular perturbation, scale time

Analysis of Two Time Scale Property of Singularly Perturbed System on Chaotic Attractor

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The idea that chaos could be a useful tool for analyze nonlinear systems considered in this paper and for the first time the two time scale property of singularly perturbed systems is analyzed on chaotic attractor. The general idea introduced here is that the chaotic systems have orderly strange attractors in phase space and this orderly of the chaotic systems in subscription with other classes of systems can be used in analyses. Here the singularly perturbed systems are subscripted with chaotic systems.
Two time scale property of system is addressed. Orderly of the chaotic attractor is used to analyze two time scale behavior in phase plane.
Keywords: chaos, singular perturbation, strange attractor, phase space

Chaotic Behavior with Fast Dynamics Modeling

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The idea that with higher accuracy modeling and considering the fast dynamics in non-chaotic system it may carry chaotic behavior on its dynamic is investigated here. The singularly perturbed models are models that contain fast dynamics of systems but for simplicity in applications the slow behavior of systems is considered commonly. Here with an example showed that neglecting fast dynamics in chaotic singularly perturbed systems can result in non-chaotic and stable dynamics and it can be concluded that modeling fast dynamics in some non-chaotic system results in chaotic behavior on dynamics of the system.
Keywords: Chaos, Fast dynamics, Modeling, Singular perturbation

OGY Control on First Order Approximation of the Slow Manifold

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Control of chaotic systems is the subject of interest of many researchers. In OGY method of chaos control, an unstable manifold is defined and intersections of the system trajectories with this manifold yields the discreet model of the system (Poincare map). Control of this discreet model (controlled Poincare map) result in control of full system. Defined manifold determines the efficiency and accuracy of the method. In this paper some properties of a proper manifold to construct Poincare maps discussed. Using the singular perturbation geometry for Lorenz, Lu and Chen model, the slow manifolds are obtained. Then, for these unstable manifolds the first order approximation is calculated. And the OGY control on different manifold investigated.
Keywords: Chaos, Lorenz, Lu, Chen, slow manifold, Poincare section, Singular perturbation

Nonlinear oscillations and chaotic response of Shape Memory Alloys

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Shape Memory Alloys (SMAs) present unusual behaviour compared to more standard linear elastic materials. Indeed, they can accomodate large reversible strain (pseudo-elasticity) or recover their shape, after being strained, by simple heating (shape memory effect). These behaviours are due to a displacive first order phase transformation called martensitic transformation. These features promote their use in many applications ranging from biomedical field to spatial domain. In the current work, we focus on the pseudoelastic behaviour. To this end, the thermomechanical constitituve law developped by Moumni and Zaki [1] is used. Firstly, the behaviour is reduced to a single degree of freedom. Secondly, inertial effect is considered and the forced oscillations of a device witnessing a pseudoelastic behaviour are studied. The analysis of the results through frequencyresponse curves and Poincar´e maps reveals softening behaviour, jump phenomena, symmetry-breaking bifurcations and occurence of chaos. Results are in good agreement with those found in the literature [2] and using a different modelisation of the shape-memory effect.
Keywords: hysteresis loop, damping capacity, softening behaviour, chaotic solutions, symmetry breaking, Poincare map.

Chaotic advection in a 3-D periodic flow

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Chaotic advection and heat transfer is studied and analyzed in a three dimensional, periodic, Stokes flow. The system studied is the laminar flow between two eccentric, rotating tubes tubes. The inner tube rotates with a periodic angular velocity and the outer tube rotates at constant speed. The laminar flow between the two tubes is thus three-dimensional and periodic. This flow is actually the much studied journal bearing flow with an constant axial velocity component. This apparatus is important for engineering applications because it is particularly effective both in the heating of highly viscous organic liquids with a high Prandtl number and in the continuous mixing of two viscous liquids. The first experiments on this flow were realized by Kusch and Ottino [1]. These experiments clearly show chaotic streak-lines for certain conditions, however no theoretical analysis was given at that time. Many tools which are valid for Hamiltonian systems such as the two dimensional journal bearing flow (Poinaré sections, analysis of periodic points, etc.) can no longer be used or cannot provide useful information for this three dimensional periodic flow. In the journal bearing flow the instantaneous angular velocity ratio of the two cylinders is the only dynamical parameter on which the system depends; however, in the three dimensional flow considered here, the axial velocity and its ratio to each of the two angular velocities plays an important role, as was inferred by the experiments of Kusch and Ottino [1].
To study and optimize the response of this dynamical system we have developed a numerical experiment based on the analogy between momentum, heat and mass transfer. Fluid with a linear, radial temperature distribution enters an adiabatic heat exchanger which is really this flow system. Chaotic advection will lead to a homogenization of the radial temperature distribution at the outlet, a parameter based on this phenomenon can be used, as Lyapounov exponents, to quantify chaos in this flow. To achieve this we have solved the three dimensional, periodic convection diffusion equation numerically. For a given instantaneous angular velocity ratio of the two cylinders, the analytical three dimensional velocity field obtained for constant rotation of both cylinders was used. This assumption, based on a small Strouhal number (which is the case here) helps in reducing greatly the calculation time. Two dimensionless parameters have been defined, the first one is based on the number of turns the cylinder moving at constant velocity makes per average fluid residence time in the heat exchanger and the second parameter is a measure of the number of periods the cylinder turning at a periodic angular velocity makes per average residence time [2-3]. Chaos can be quantified by calculating the average standard deviation of the temperature field at the exit. The numerical experiments have shown that for a certain range of values of the dimensionless parameters defined above chaotic streak-lines are apparent. For higher and lower values the streak-lines are regular. Chaotic advection leads to a homogenization of the exit temperature field.

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Synergistics approach to aircraft actuators control

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We explore aircraft actuators control based on nonlinear mathematical models of aircraft motion. The aim is spatial orientation of the aircraft. We use synergetics theory of control and method of analytical design of aggregated regulators to design nonlinear control laws. This synergetics approach makes possible improve efficiency, accuracy, and dynamical properties of aircraft control systems.

Keywords: modeling, mathematical models, aircraft control, regulators, non-linear dynamics, non-linear systems, non-linear control, actuators

Chaotic behavior in nonlinear system

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A five-modes truncation of the Navier-Stokes equations for a two dimensional incompressible fluid on a torus is considered. It was found that, under certain conditions, the system displays chaotic behavior. Also bifurcation diagram and the chaotic behavior of the model is demonstrated.

Key words: chaos, bifurcation, Lyapunov exponents.

Synergetics approach to aircraft spatial motion nonlinear control: special control laws

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Synergetics control theory provides control laws synthesis for aircrafts spatial motion. Basing on these laws we can design a new class of autopilot devices and providing new features. But implementation of these control laws for aircraft actuators has some difficulties. Synergetics controls has hierarchical structure, and on the first step control aircraft forces and moments. But adaptation of these laws to aircraft actuators is an individual problem. In this work we develop vector control algorithms for spatial motion control of some speculative aircraft including real constructive parameters. We propose some methods to design control laws for particular aircrafts basing on common fundamental laws of control, that were obtained in previous works [1-3]. Mathematical system modeling and computer simulation are also provided.
Keywords: aircraft, autopilot, nonlinear control, hierarhical control, synergetics control theory, ADAR method

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Influence of activator-inhibitor transport ratio on Turing patterns in three coupled CSTRs with glycolytic oscillatory reaction

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This work study three CSTRs in parallel, coupled by two membranes, in order to find and analyse Turing instability. Our goal is to extend the theory of compositional complementarity in the origin of life and propose usage of Turing

patterns as memory arrays and cellular logical units. Every CSTR have glycolytic oscillatory reaction, which is realized by model proposed by Moran and Goldbeter (1984). Turing instability reacts sensitively to ratio of transport of activator and inhibitor through every membrane it the system. Solution diagrams and Turing patterns as schematic concentration profiles are shown for three different ratios of transport coefficients of inhibitor and activator *q=100*, *q=1* and *q=0.8*.
Keywords: Turing instability, Turing pattern, glycolysis, memory array, logical unit

Improvement Performance of TH-UWB System Using Spatiotemporal Chaotic Sequences

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The residential environments are an important scenario for Ultra Wide Band (UWB) communication systems. In this paper, the performance of correlating receivers operating in a Line-Of-Sight (LOS) scenario in these environments is evaluated. In such channel the interference between users is an additional source of noise, that may deteriorate the performance of the system. In this research axis; it aims to exploit the richness of chaotic and spatiotemporal sequences with respect to topologic properties.
We check through simulations, that chaotic sequences are shown to have improved performance compared to the Gold sequences in terms of Bit Error Rate (BER).
Keywords: Time hopping Utra wide band, Chaotic sequences, Multi-path channel, Spatiotemporal.

Factor Analysis (FA) as ranking and an Efficient Data Reducing approach for decision making units: SAFA Rolling & Pipe Mills Company case study

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This article compares two techniques: Data Envelopment Analysis (DEA) and Factor Analysis (FA) to aggregate multiple inputs and outputs in the evaluation of decision making units (DMU). Data envelopment analysis (DEA), a popular linear programming technique, is useful to rate comparatively operational efficiency of DMUs based on their deterministic or stochastic input–output data. Factor analysis techniques, such as Principal Components Analysis, have been proposed as data reduction and classification technique, which can be applied to evaluate of decision making units (DMUs). FA, as a multivariate statistical method, combines new multiple measures defined by inputs/outputs.

Nonparametric statistical tests are employed to validate the consistency between the ranking obtained from DEA and FA. Also, the results have been compared with PCA approach. SAFA Rolling & Pipe Mills Company's data is used as a case study to consider the proposed approach in practical. Results of numerical reveal that new approach has a consistency in ranking with DEA.

Keywords: Data Envelopment Analysis; Factor Analysis, Principal Component Analysis; Decision Making; Data Reduction

Synchronization, Hysteresis and Bifurcations in Multimode Nd: YAG Lasers

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Nd:YAG laser with intracavity KTP crystal has been known to exhibit chaotic fluctuations in intensity in the second harmonic output. In the present paper we investigate numerically the dynamical behaviour of such lasers under various conditions of operation. Under positive or negative optoelectronic feedback the single laser displays a variety of interesting dynamics such as hysteresis and bistability. It also shows Hopf bifurcation.We have also numerically investigated the synchronization properties of two such coupled chaotic lasers with unilateral and bilateral coupling schemes and also with different polarization states of the laser modes. For some parameter values the coupled system shows behaviour similar to anomalous synchronization.

Transport suppression via shear in turbulent flows

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The suppression of turbulent transport by largescale shear flows is demonstrated numerically by measuringthe turbulent diffusion D_t and scalar amplitude$langle n'^2rangle$ of decaying passive scalarfields n' being advected by various turbulentflows. The nature of transportsuppression is shown to be crucially depends on thethe temporal correlation of the turbulence.Decorrelated prescribed turbulence ($tau_c=rightarrow 0$)is found to suppress thetransport statistics with the shearing rate $Omega$ in the strong shear limit as$D_t propto Omega^{-0.02}$, $langle n'^2rangleproptoOmega^{-0.62}$ and$costhetaproptoOmega^{0.29}$. For finite correlatedconsistently evolved turbulence ($tau_c ge Omega^{-1}$),the scalings of the turbulence statistics with $Omega$in the strong shear limitare found to be much stronger than those for thedecorrelated turbulence, with scalings of$D_tproptoOmega^{-1.75}$, $langle n'^2 rangle proptoOmega^{-2.41}$,$langle u_x'^2 rangle propto

Omega^{-0.65}$ and$langle omega'^2 rangle propto Omega^{-0.50}$.The results from these different turbulent flows, throughutilising a novel renormalisation, are shown toclosely match analytical predictions [see E. Kim, Mod. Phys.Lett B {bf 18}, 1 (2004)] for the behavior of D_t and$langle n'^2rangle$.The renormalisation process provides previously unseeninsight into the underlying nature of transport suppressionby flow shear showing how all the transport statisticsare interrelated.

Functional and Gradient Stochastic Flows with Jumps Associated with Nonlinear SPDEs

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There are investigated two problems relying on SDEs with jumps in the presence of a mutually commuting assumption imposed on the vector fields driving the motion, which in turn will imply a useful integral representation for the solutions of the SDE's under consideration. In addition, a fundamental system of stochastic first integrals can be constructed provided the conditions of the contraction mapping theorem are satisfied. The general method we relied on made use of piecewise smooth test functions constructed as fundamental solutions for convenient quasilinear Hamilton-Jacobi equations with jumps. The main results concluding the presentation were obtained either associating the evolution of some pathwise functionals with nonlinear SPDEs of parabolic type or by introducing appropriate parameterized backward parabolic equations.

Chaotic and dynamic properties of many-particle classical dynamical systems

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Many-particle systems which consist of moving atoms and molecules are usually considered as dynamical systems. The motion of classical particles is governed by the reversible Hamiltonian dynamics. However it is well known since the discovery of the second law of thermodynamics and the Boltzmann works that many-particle classical systems manifest properties of stochasticity and irreversibility as well. More than 100 years later this problem concerning foundations of statistical mechanics remains to be carefully understood. The molecular dynamics modeling and simulation presents the unique possibility to treat the problem from the atomistic view. The molecular dynamics method

(MMD) becomes an important tool in condensed matter physics, chemical physics, biophysics etc. It is based on the numerical solution of the Newtonian equations for systems of many particles, interacting with each other. Characteristics and properties of relaxation processes or equilibrium systems are extracted from the analysis of the particle trajectories calculated. The results point to the ergodicity, remixing and irreversibility without any additional hypothesis or assumption. Therefore the origin of irreversible and chaotic behavior of the real molecular many-particle systems can be analyzed on the basis of the MMD approach. With this purpose the MMD theory is developed: Lyapunov exponential trajectory divergence, dynamic memory time (predictability horizon), small but finite fluctuation of the total energy (break of the energy conservation law in MMD), stochastic and dynamic properties of MMD systems, irreversibility emergence. The correspondence between MMD and real systems is elucidated. Probabilistic nature of the classical statistical physics is demonstrated. Based on the theory developed requirement standards are formulated for MMD modeling of both relaxation processes and equilibrium systems (particle number choice, initial and boundary conditions, diagnostics etc).

Study of nonlinear behaviour of glucose – glucose oxidase – ferricyanide reaction

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The work summarizes experimental findings on dynamics of the enzymatic reaction glucose – glucose oxidase – ferricyanide with or without sodium hydroxide in a continuous-flow stirred tank reactor (CSTR) and in a batch reactor. Due to presence of the enzyme glucose oxidase, which is ubiquitous in organisms, the reaction serves as a model of certain functions in living systems. This reaction is reported to provide nonlinear dynamic behaviour including bistability and excitability. The reaction exhibits pH-variations having autocatalytic character. The dynamics of the reaction were examined as inlet parameters were varied. The main inlet parameters in a continuous-flow stirred tank reactor were the ratio of concentrations of sodium hydroxide and ferricyanide and the flow rate. In the batch reactor we observed a well-pronounced autocatalytic drop of pH. In the CSTR we observed a switch from a high pH steady state to a low pH steady state. Experimental tests an excitability are performed. A model of the glucose oxidase system is used to predict response to periodic perturbations. The response involves phase-locking and chaotic oscillations.
Keywords: bistability, excitability, enzymatic reaction, glucose oxidase.

Tronqu'ee solutions of the Painleve' II equation

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The distribution of poles of special solutions to Painlevé II equation, specified by P.Boutroux as intégrale tronquée, is studied in the complex plane. These solutions are meromorphic everywhere except some critical sectors where they have regular asymptotics at infinity. All famous solutions of Painleve' II, such as Hastings-McLeod, Ablowitz-Segur and others, are of this type. We study the Riemann-Hilbert (RH) problem related to the specified solutions as an integration tool of the Painleve' II. It is “undressed" to a similar RH problem for Schrödinger equation with quartic potential in the limit of Laurent expansion near the pole. The latter RH problem determines all coordinates of poles via a Bohr-Sommerfeld quantization conditions for the quartic potential. Numeric simulations show a good approximation for the poles distribution in the complex plane outside the small circle near the origin.

Chaos dynamics in an error diffusion model

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A model of error diffusion inspired by an application of a color printing algorithm typically shows an unexpected chaotic behavior. This chaotic behavior, similar to an ergodic translation on an n-dimensional torus makes the resulting color prints much smoother and devoid of artifacts.

The direct scattering of the parametrically driven nonlinear Schrödinger equation

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The parametrically driven nonlinear Schrödinger equation (PDNLS), i\psi_{t}+\psi_{xx}+2\left|\psi\right|^{2}\psi-\psi=h\psi^{*}-i\gamma\psi, is a near-integrable equation that arises in various physical systems, including plasma physics and Josephson junction theory. Attractors, emerging when the localised solutions become unstable, are investigated numerically. In particular, the soliton content of these attractors is studied in terms of inverse scattering theory. This is done by calculating the discrete eigenvalues of the Zakharov-Shabat eigenvalue problem, associated with the unperturbed nonlinear Schrödinger equation. We

show that the discrete eigenvalues of the PDNLS have the same dynamical behaviour as the localised attractors. In addition, we found regimes where additional discrete eigenvalues periodically appear and disappear. As the driving strength increases, more eigenvalues are formed, ultimately leading to spatio-temporal chaos.

Factor maps and distributional chaos

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Let X, Y be compact metric spaces, let f C(X); g C(Y) be continuous self-mappings and π : X → Y be a factor map between f and g.
In this talk we will present sufficient conditions on π which allow to transfer chaotic dynamics from g to f (we will mainly focus on distributionalchaos).
We will also comment how geometric approach (more speciffally, the method of isolating segments) may help in the construction of such a π. As a testing ground, we will use Poincare maps for the perturbations of the planar ODE of the type

$$\dot{z} = \left(1 + e^{ikt}|z|^2\right)\bar{z}\,.$$

Keywords: distributional chaos, factor, topological entropy, Poincare map, isolating segments

Some Problems of Convergence and Approximation in Random Systems Analysis

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From some time past our interest was focused to find new possibilities for characterizing the process of generation of the words by generative systems. In some previous papers we have introduced numerical functions able to characterize classes of derivations according to a given generative system (as the phrase-structure grammars known in formal languages) up to an equivalence. Our interest is now to establish some new properties of symmetry and invariance. On the other hand, when a differential equation is considered if it is allowed for some randomness in some of its coefficients, it will be often

obtained a so-called "stochastic differential equation" which is a more realistic mathematical model of the considered situation.
The stochastic-approximation procedures require very little prior klowledge of the process and achive reasonably good results, and for this reason such methods work satisfactorily in various applications. For this reason we shall refer, in short, to the Brownian motion as one of the most important stochastic processes and also to some applications.
Keywords: generative system, stochastic differenial equation, Markov property, Brownian motion, stochastic process.
2000 MS Classification: 60H10, 60J20, 60J65, 60H30, 68Q45.

Structural resonances of Strong Blast

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This work is devoted to investigation of functional state space of compressed medium at Strong Blast in terms of self-organization of open systems (1-2). Similar to previous work, we apply Rankin-Gugonio method of integral sections, which allowed forecasting the existence of dispersed detonation waves without a chemipeak, and explain the nature of dispersed shock and detonation waves in heterogeneous media. The solution family was derived in transcendental functions. Polar coordinate system was used for effective resolution of features. Korobeinikov limits were applied to determine the constants of the coarse-grained structure of functional state space of trial compressed particles A at Strong Blast. A satisfactory agreement of the derived values of constant A with numerical values of Zommerfeld fine structure constant was demonstrated, which can be regarded as indirect proof of the presence of succession in structural organization of matter on micro- and macrolevel. ! Values of the constant of coarse-grained structure A in the presented fractals are equal to 135.6236(-1), 136.2015(-1) и 137.0897(-1), respectively. The physical sense of the derived solution of the Strong Blast problem consists primarily in that the irreversible processes in the are indeterminate in time and space and this problem does not have an unambiguous solution. The question of whether all the process scenarios are implemented in the Strong Blast simultaneously or sequentially is till open. Experimental data on new material synthesis by blast waves is an indirect by blast waves is an indirect indication of a simultaneous realization of a family of mixed states, for instance formation of various diamond phases in blast waves of specified intensity. This is further indicated by patterns realized at running of irreversible processes of plant growth. It is shown, that in biological objects the fractals related to Fibonacci invariants prevail, that confirms their important role in self-organization of thermodynamically open systems at a distance from thermodynamic equilibrium. In conclusion, it should be noted that the very fact of appearance of a fundamental constant in solutions of Strong Blast problem is indicative of the fact that physical models of blast waves as partially ordered structures

Keywords: self-organization, irreversible processes, Strong Blast, biological objects, coarse-grained structure, fine structure constant are highly promising for future application.

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Construction of Chaotic Generator Using Active Devices

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A chaotic generator based on two operational amplifiers, three capacitors and four resistors is described. The circuit is simulated using PSpice and the hardware implementation is done. The circuit can be implemented easily by using simple available electronic devices in electronics lab. Basically the circuit is an oscillator which behaves chaotically for some values of R. This circuit has low power spectral density thus it can be used as a chaotic generator in many indoor and mobile applications

Index terms- Chaotic, PSpice, Oscillator.

Simple Chaos Generator

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A Chaos generator based on two operational amplifier(IC 741), three capacitors and four resistors is described. The chaotic attractors has been observed with an extremely simple circuit. The circuit is designed on PSpice and practically implemented on breadboard. The circuit is analyzed and parameters are calculated.

Index Terms : chaos , attractor,oscillators

Chaotic Communication: An overview

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Chaotic communication is a way to utilize the potential of chaos in communication. In this approach, message signal is mapped on to a chaotic signal and at the receiver same key is to be generated to get the actual information. Chaotic signals are easily generated and are aperiodic, impossible to predict, wide band signals having low power spectral density thus they have all advantages of spread spectrum signals. One major advantage of chaotic signals is that they are more secured because only intended receiver can received the signal. This paper provides an overview of chaotic communication, chaos generators and chaotic modulation schemes.
Index terms-Chaotic Communication, Spread Spectrum

Chaotic Dynamics of Coupled Nonlinear Circuits in Ring Connection

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It is generally difficult to synchronize a ring network that features chaotic behaviour, especially if the system's order is too large. In this paper, we consider a ring network of three identical nonlinear and non-autonomous circuits of fourth order, which are bidirectionally coupled through three coupling linear resistances R_C. We present simulation and experimental results for synchronization of such a network in low frequency area, and derive a sufficient condition for chaotic synchronization of this type of network.
Keywords: Ring connection, Nonlinear circuit, Low frequency area, Chaotic synchronization.

Theory of Violent Relaxation by Real-Space Renormalization

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Mathematical models of plasmas, galaxies, and fluids can be interpreted as continuous time classical mechanical systems of point particles (vortices etc.) with slowly decaying, long-range interaction potentials. In conditions of high temperature plasmas, large aggregations of stars, or ideal fluids, one can neglect the fluctuating random interactions between individual particles. Such "collisionless" conditions create a wide variety of interesting dynamical phenomena such as the Landau damping in plasmas, the magnetohydrodynamic shock waves, or the core-halo formation instabilities of galaxies.

Very generally, one would like to have a consistent and accurate, and if possible analytic, description of the evolution of the coarse-grained distribution function of particles in phase space, starting from a non-stationary intial distribution. This is a very hard task numerically because the fine-grained distribution tends to stretch and fold rapidly down to very small scales in the so-called "violent relaxation." The situation cannot be cured by introduction of some artificial dissipation into the equations, because that typically spoils the asymptotic distribution. The Lynden-Bell's "theory of violent relaxation" has some serious shortcomings too.
A method of real-space renormalization is applied to investigate the dynamics (of violent relaxation). This method is applied to a classical system of particles on a lattice with the long-range "alpha-phi^4" Hamiltonian. The equivalence between Klimontovich and BBGKY descriptions of the Vlasov equation are used to construct a special ensemble averaging procedure, by which the effective coupling constant is computed. The concept of reducing the attractor of a many-body system to its mean-field "essential" component is discussed.

Mode-competition in flow-oscillations investigated by means of symbolic-dynamics

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The dynamical mode-switching phenomenon, between two dominant frequencies of oscillation in a self-sustained oscillating cavity-flow, is investigated by the means of dynamical system analysis and symbolic dynamics. Two symbols are attributed, according to a partition of the angular first-return map to a Poincaré section. As a result, each symbol is mainly associated with a given mode of oscillation.
Keywords: Fluid mechanics, self-sustained oscillating ows, Poincaré section, angular first-return map, symbolic dynamics.

Chaos Control Applied To Mechanical Systems

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Chaos may be exploited in order to design dynamical systems that may quickly react to some new situation, changing conditions and their response. In this regard, the idea that chaotic behavior may be controlled by small perturbations allows this kind of behavior to be desirable in different applications.

Chaos control may be understood as a two stage technique: the first one is known as learning stage where the unstable periodic orbits (UPOs) embedded in chaotic attractor are identified and system characteristics are evaluated; after that, the control stage stabilizes desired UPOs. This paper presents an overview of chaos control methods classified as follows: OGYmethods – that includes discrete and semi-continuous approaches; multiparameter methods – that also includes discrete and semi-continuous approaches; and time-delayed feedback methods that are continuous approaches. These methods are employed in order to stabilize some desired UPOs establishing a comparative analysis of all methods. Essentially, a control rule is of concern and each controller needs to follow this rule. Noisy time series is treated establishing a robustness analysis of control methods. The main goal is to establish a comparative analysis of chaos control methods evaluating the capability of each method to stabilize a desired UPO analyzing its performance
Keywords: Chaos, control, noise, nonlinear dynamics, pendulum

Construction of Dynamical Systems from Output Regular and Chaotic Signals

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The problem of construction of the deterministic dynamical system from output signals (reconstruction) is very important. Two reconstruction methods have been used and compared. First one is the method of successive differentiation and the second is based on delay coordinates. It was firstly suggested to choose time delay parameter from the stable region of a divergence of the reconstructed system. Results show that both methods can capture regular and chaotic signals from reconstructed systems of the third order with nonlinear terms up to sixth order. Types of signals were examined with spectral methods, construction of phase portraits and Lyapunov exponents.
Keywords: Reconstruction, Dynamical system, Chaotic regime, Successive differentiation, Delay time.

Analysis and Circuit Realization of A New 3D Chaotic System

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This paper introduces a new three-dimensional quadratic continuous autonomous chaotic system with golden proportion equilibria, which can generate single folded attractor. Some basic dynamical behaviors, and the dynamical structure of the new chaotic system are investigated either analytically or numerically. Finally, the chaos generator of the new chaotic system are

experimentally confirmed via a novel electronic circuit design. It is convenient to use the new system to purposefully generate chaos in chaos applications. A good qualitative agreement is illustrated between the simulations and the experimental results. Following nonlinear autonomous ordinary differential equations are the new chaotic system.

$$\begin{aligned} \dot{x} &= y - x - a \cdot z \\ \dot{y} &= x \cdot z - x \\ \dot{z} &= -xy - y + b \end{aligned} \qquad (1)$$

Keywords: Chaotic attractor, chaotic system, golden proportion, golden equilibria, chaotic circuit, chaotic oscillator

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Four-Scroll Stellate New Chaotic System

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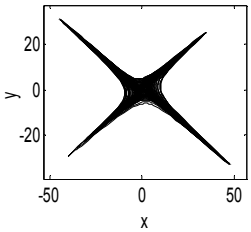
This paper introduces a new chaotic system of three-dimensional autonomous ordinary differential equations, which can display strange four-scroll stellate chaotic attractors simultaneously. Some basic dynamical behaviors of the new system investigated via theoretical analysis by means of equilibria and Lyapunov exponent spectrum. Finally, the chaos generator of the new chaotic system is experimentally confirmed via a novel analogue circuit design. It is convenient to use the system to purposefully generate chaos in chaos applications. A good qualitative agreement is illustrated between the simulation and the experimental results.

$$\dot{x} = -a \cdot x + y + y \cdot z$$
$$\dot{y} = x - a \cdot y + b \cdot x \cdot z$$
$$\dot{z} = c \cdot z - b \cdot x \cdot y \quad (1)$$



Keywords: Chaos, chaotic system, chaotic attractor, chaotic circuit, four-scroll, chaos generator

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Control methods for informational systems with distributed parameters

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We consider a mathematical tool that allows to retrieve information from distributed information signals modulated functions that depend on spatial coordinates (spatial modes). This extraction is carried out using spatial scanners and spatial filters. Spatial scanners can detect spatially-modulated signals (through the spatial scans) in a distributed data signals, and spatial filters are separated from the considered signal given spatial modes (transmission line). We provide examples of the implementation of distributed information processing systems, as well as results of computer simulation.

Creating Interactive Music with Fractals

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Mandelbrot's [5] book is at the root of the fascinating new way of looking at the beauty of fractals. See also Peitgen [6], Pickover Briggs [1], [7], Flake [2], Lesmoir-Gordon [4], Schroeder [9], among others. Algorithmic music composition is dealt with in Johnson [3], and Sotiropoulos [10], [11], [12] is a coordinated overview of the state-of-the-art in this field.
Musical variation, and composition rules defined by Schönberg, exploit to a certain extent the self-similarity of fractals, and Lindenmeyer (cf. Rozenberg [8]) created algorithms (in biological research) that can be exploited fully using iteration in algorithmic music composition. But can fractals create harmony of sound and *cantabile* music as well as they create beauty for the eyes in graphical arts?
We present examples of an interactive algorithmic music composition system exploiting Lindenmeyer's technique, generating some forms of minimalist music based on user input, and further developments using the interaction of probability models, fractals and chaos.
Keywords: Algorithmic music composition, fractals in music, Lindenmeyer systems.

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Lindenmeyer Systems and the Harmony of Fractals

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An interactive musical application is developed for realtime improvisation with a machine based on Lindenmeyer-systems. This has been used on an installation whose goal is to draw the attention of unexperienced users to the wealth of realtime applications in computer music. Issues on human computer interaction and improvisation grammars had to be dealt with, as well as probabilistic strategies for musical variation. The choice of L-systems as a basis for machine composition is a consequence of their ability to create results that easily have aesthetic appeal, both in the realms of sound and image.
Keywords: human-computer interaction, L-systems, fractals in algorithmic music composition, interactive composition, improvisation, computer music.

Exotic features in two coupled rings of cells

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We study the bifurcation scenario appearing in systems of two coupled rings of cells with Z3xZ5 exact symmetry, and Z3 interior symmetry. This study was motivated by previous work by Antoneli, Dias and Pinto, on two rings of cells coupled through a 'buffer' cell, with Z3xZ5 and D3xD5 exact and interior symmetry groups. There, quasi-periodic behavior was found through a sequence of Hopf bifurcations. We questioned if an analogous mechanism could explain the appearance of quasi-periodic motion in the examples considered here. Surprisingly, we observe periodic and quasi-periodic states appearing also through Hopf bifurcations. We compute the relevant states numerically.
Keywords: Hopf bifurcation, exact symmetry, interior symmetry, coupled cells systems.

Creating chaos from a family of vector fields on R^n admitting a Hopf bifurcation

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This talk deals with the problem of creating a chaotic differential system from a generic one-parameter family of smooth vector fields on R^n, that exhibits a Hopf bifurcation, by imposing a dynamics on the parameter.
Motivations of this work comes from the mathematical analysis of a hypothetical gene regulatory network, with four variables and nineteen parameters, designed by J.J Tyson.
We begin the talk by showing that, using ideas that have been already studied by many people as L.O Chua and R.Lozi, it is possible to get such a chaotic behaviour by constructing a Poincaré map with a Horseshoe thanks to a hysteresis dynamics imposed on the parameter. Then we show how to apply this result so as to induce a chaotic behaviour in our four dimensional differential system and conclude by showing the numerical results that confirm the presence of chaos.

Elastic Pendulum

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Elastic pendulum is a simple mechanical model with a wide range of dynamical regimes. The stability of vertical oscillation is studied, the bifurcation responsible for the loss of stability is identified and the branch of periodic solution is found. The method of continuation is used to find the border of stability and special attention is devoted to continuation of periodic solutions of conservative systems.
Keywords: elastic pendulum, hamiltonian dynamical system, bifurcation, continuation of periodic orbits of conservative systems.

Chaotic maps in cybernetics

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The necessary and sufficient conditions for solvability of the family of difference equations with periodic boundary condition were obtained using the notion of relative spectrum of linear bounded operator in Banach space, and the

ergodic theory. Some of such systems was implemented using Wolfram Mathematica framework. We can see unpredictable behavior.

Synergetics synthesis of control systems for processes of in-flight refueling

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The report is devoted to solution of a problem of in-flight refueling automation. The process of in-flight refueling is very complex. It's need to high piloting technique and high accuracy of control system. The autopilot synthesis for stages of final aircraft approach and fuel line capture is presented. This autopilot ensures high positioning accuracy, compensation of force and wind disturbances. Aircraft mass changing is also taken account.
Keywords: aircraft, nonlinear control, synergetics control, chaotic disturbances

Chaotic synchronization of complex networks with Rössler oscillators in Hamiltonian form like nodes

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Recently the study of complex dynamical networks has been increased, is due to that many systems -in different fields- have been observed and characterized by this type of structures, for example in: physics, biology, computer sciences, economy, chemistry, engineering, social sciences. Many systems in nature and in technology are made by a large number of highly interconnected dynamical units in regular and irregular complex networks. For example, nervous systems, metabolic networks, citation networks, electronic circuits, anthills, a set of pages web of the network connected through link, lasers, social groups, biological systems, robots to perform an identical task, chaotic oscillators networks, etc.In this work, synchronization of chaotic Rössler oscillators in Hamiltonian form is numerically studied. Synchronization of multiple chaotic Rössler oscillators is achieved by appealing to complex systems theory [1-4]. In particular, dynamical networks composed by Rössler oscillators as interconnected nodes in Hamiltonian form are considered, where the interactions in the networks are defined by coupling the first state of each node. The main topology that we consider is the globally coupled network. Two cases of interest are considered: i) synchronization without master Rössler oscillators (where the collective behavior is a new chaotic state) and ii) with master Rössler oscillator (where the collective behavior is imposed by the dynamics of the master node to multiple slave nodes).

Keywords: Synchronization, Complex Networks, Chaos

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Bifurcation Analysis of Multibody Parafoil-Payload System

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The bifurcation theory is suitable to predict nonlinear dynamics, and stability of parafoil-payload system caused due to multibody dynamics, and presence of vertical offset between the parafoil aerodynamic center and the suspended payload center of gravity. Parafoil is high performance gliding parachute with sufficient control authority to steer it along desired path to achieve guided payload delivery for variety of application. But nonlinear dynamics and stability prediction is necessary before designing guidance law for a guided parafoil-payload delivery system. This paper rightly highlights the importance and application of Bifurcation theory for nonlinear dynamics and stability prediction using multibody Nine Degree-Of-Freedom (9-DOF) parafoil-payload concept. The advantage of 9-DOF model is that it allows to model the parafoil-payload system as multibody system with provision to incorporate aerodynamic forces and moments of parafoil and payload at their respective e locations.
Keywords: Bifurcation Methods, Multibody System, 9-DOF system, Parafoil-payload System, Stability, Trim.

System of induction motor vector control: synergistics approach

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In the paper we explore the problem of control algorithms design for induction motor (IM) based on synergistic approach. We use IM mathematical model for rotating coordinate system directed by rotor flux linkage vector. To use

all advantages of this coordinate system during design procedure we built an observer for rotor flux linkage vector. This observer makes estimation by data from current and voltage sensors on stator windings.
Keywords: induction motor, modeling, motor control, synergistics approach, regulator, non-linear systems, non-linear control.

Electron-electron Collisions and Drift Velocity Fluctuations in n-GaAs at T=80 K

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Modified combined scattering rate Monte Carlo technique is proposed. Electron collisions with phonons, impurities and among themselves are taken into account. The proposed technique avoids the short-time-step procedure inherent to conventional ensemble Monte Carlo method. All *N* modeled electrons move using the total probability for the scattering of each electron by the thermal bath and mutual scattering between electrons pairs ("events in the electron system"). The quantitative fitting to the available experimental data on the spectral density is achieved and the range of moderate fields is defined for interparticle collisions to manifest themselves in the noise. In the second part of the presented report a drift velocity correlator is investigated numerically by Monte Carlo simulation and for the fist time analytically by a phenomenological approach taking into account electron-phonon and electron-electron scattering between free carriers. The thermodynamic approach is investigated. The results of the velocity-to-velocity correlation functions and electron noise spectrum obtained analytically are in quite good agreement with those given by the Monte Carlo method.
Keywords: Monte Carlo, Electron-electron collisions, Drift velocity fluctuations, Spectral density.

Nonlinear Dynamics of Bloch Electrons in Indium Antimonide Crystals Excited by Picosecond Electric Field Pulses

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Modified combined scattering rate Monte Carlo technique is proposed. Electron collisions with phonons, impurities and among themselves are taken into account. The proposed technique avoids the short-time-step procedure inherent to conventional ensemble Monte Carlo method. All *N* modeled electrons move using the total probability for the scattering of each electron by the thermal bath and mutual scattering between electrons pairs ("events in the electron system"). The quantitative fitting to the available experimental data on the spectral density is achieved and the range of moderate fields is defined for interparticle collisions to manifest themselves in the noise. In the second part of

the presented report a drift velocity correlator is investigated numerically by Monte Carlo simulation and for the fist time analytically by a phenomenological approach taking into account electron-phonon and electron-electron scattering between free carriers. The thermodynamic approach is investigated. The results of the velocity-to-velocity correlation functions and electron noise spectrum obtained analytically are in quite good agreement with those given by the Monte Carlo method.

Keywords: Monte Carlo, Electron-electron collisions, Drift velocity fluctuations, Spectral density.

Microwave heating of the ceramic materials by the Gaussian beam

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The ceramic which has a complex permittivity can absorb electromagnetic energy easily and be heated quickly. In this work, the heating of a ceramic cylinder by the Gaussian electromagneticbeam in two dimensions is investigated and the heat equation issolved. It is shown that this electromagnetic beam with Gaussianprofile can heat ceramic sample better than the planeelectromagnetic wave. Moreover, the effects of some importantphysical factors such as the permittivity of ceramic, the incidentwave intensity and the spot size of the Gaussian beam on the heattransfer within the sample are studied. Also, comparing the effectof Gaussian electromagnetic beam on ceramics Al_2O_3 and ZnO, it is shown that Al_2O_3 ceramic is heated more intensively than ZnO ceramic.

Keywords: microwave ceramic, microwave, Gaussian beam

The dissipation effects on Transition of Electromagnetic Wave Through a Warm Overdense Plasma Layer

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It is investigated the high transparency condition of an overcritical warm plasma layer with dissipation.
The dissipation effect is considered by introducing a complex permittivity into the theory. In fact an overcritical warm plasma layer is opaque for electromagnetic waves. However it has been shown that when it is sandwiched between two dielectric layers, due to excitation of the surface plasmons and under resonance conditions, the electromagnetic wave can pass through them [ref]. Here it is added the dissipation effects and a comparison is made between tow cases, with and without dissipation.

Keywords: Dissipation effect-Overdense plasma

Angular Momentum Method for Analysis of Irregular Time Series

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A quantity formally similar to averaged angular momentum is computed for many chaotic scalar time series with additional Gaussian noise. Considered time series are constructed using iterative maps, three-dimensional ODEs and computer generated noise. Using proposed method we can distinguish chaos with noise from pure noise, if level of noise in time series is low enough. Some types of chaos can be detected in short time series with very high level of noise.
Keywords: chaos, noise, time series

Stability of solutions to some evolution problems

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Large time behavior of solutions to abstract differential equations is studied. The corresponding evolution problem is:

$$\dot{u} = A(t)u + F(t,u) + b(t), \quad t \geq 0; \quad u(0) = u_0, \quad (*)$$

Here $\dot{u} := \frac{du}{dt}$, $u = u(t) \in H$, $t \in \mathbb{R}_+ := [0,\infty)$, $A(t)$ is a linear dissipative operator:
$Re(A(t)u,u) \leq -\gamma(t)(u,u), \gamma(t) \geq 0, F(t,u)$ is a nonlinear operator, $\|F(t,u)\| \leq c_0\|u\|^p, p > 1$, c_0, p are constants, $\|b(t)\| \leq \beta(t)$, $\beta(t) \geq 0$ is a continuous function.
Sufficient conditions are given for the solution $u(t)$ to problem (*) to exist for all $t \geq 0$, to be bounded uniformly on $\mathbb{R}_+$, and a bound on $\|u(t)\|$ is given. This bound implies the relation $\lim_{t\to\infty}\|u(t)\| = 0$ under suitable conditions on $\gamma(t)$ and $\beta(t)$.
The basic technical tool in this work is the following nonlinear inequality:

$$\dot{g}(t) \leq -\gamma(t)g(t) + \alpha\big(t,g(t)\big) + \beta(t), \; t \geq 0 \; g(0) = g_0$$

which holds on any interval $[0, T)$ on which $g(t) \geq 0$ exists and has bounded derivative from the right, $\dot{g}(t) := \lim_{\varepsilon\to+0}\frac{g(t+\varepsilon)-g(t)}{\varepsilon}$. It is assumed that $\gamma(t)$ and $\beta(t)$ are nonnegative continuous functions of t defined on $\mathbb{R}_+ := [0,\infty)$, the function $\alpha(t, g)$ is defined for all $t \in \mathbb{R}_+$, locally Lipschitz with respect to g uniformly with respect to t on any compact subsets $[0, T]$, $T < \infty$, and non-decreasing with respect to g.

If there exists a function $\mu(t) > 0$, $\mu(t) \in C^1(\mathbb{R}_+)$, such that

$$\alpha\left(t, \frac{1}{\mu(t)}\right) + \beta(t) \leq \frac{1}{\mu(t)}\left(\gamma(t) - \frac{\dot{\mu}(t)}{\mu(t)}\right), \forall t \geq 0; \mu(0)g(0) \leq 1,$$

then $g(t)$ exists on all of $\mathbb{R}_+$, that is $T = \infty$, and the following estimate holds:

$$0 \leq g(t) \leq \frac{1}{\mu(t)}, \quad \forall t \geq 0.$$

If $\mu(0)g(0) < 1$, then $0 \leq g(t) \leq \frac{1}{\mu(t)}, \quad \forall t \geq 0$.

MSC: 26D10;34G20; 37L05;44J05; 47J35; 70K20;
PACS: 02.30Tb.
Key words: Dissipative dynamical systems; Lyapunov stability; evolution problems; nonlinear inequality; differential equations.

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Single-partial model of the nonlinear resonant medium

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Responses of the nonlinear resonant medium represented by set oscillators with various types of nonlinearity are investigated. Solutions of the nonlinear equations of oscillator in the form of final Volterra series in the time and frequency domains, corresponding to the nonlinear excitation, anharmonicity and to the nonlinear attenuation are received. Both the duality of mediums under consideration as well as classical nonlinear circuits and the opportunity of realization of signals real time processing in those mediums attention is paid to.
Keywords: oscillator, resonance medium, Volterra series, nonlinearity, dualism, signal processing.

Amplitude death in Mackey-Glass time delay systems

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We introduce a novel method for amplitude death in coupled time-delay systems by an indirect feedback coupling through an over-damped oscillator, in addition to direct coupling. We also study the nature of the transition from synchronized state to amplitude death state. We identify regions of different dynamical states such as synchronization, anti-synchronization and amplitude death in the parameter space of coupling strengths using numerical studies on coupled Mackey-Glass systems and extend this to a network of such systems.
Keywords: Amplitude death, Hyperchaos, coupled systems

Shannon´s Entropy and Dimensions in Multifractals

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We present two multifractal decompositions of the unitary interval, the first one using sets of the same frequency and the second using sets Jα with the same value of Holder´s exponent α associated with multiplicative process. We find the relationship between these decompositions, in fact we show that Jα is the union of infinite frequency sets. Combining this result with the fact that the spectrum of Hausdorff´s dimension of the first decomposition is given by the Eggleston´s theorem, we show that spectral dimension D(α) corresponding to the sets Jα can be found by a similar procedure proposed by Boltzmann to describe the equilibrium distribution. We also show that the Hausdorff´s dimension D(α) is an exponent of a logarithmic scaling law satisfied by the Shannon´s entropy of a multiplicative process with the escort distribution of q-order. We discuss briefly how are connected these results with the Halsey´s multifractal description.
Keywords : Multifractal decomposition, Shannon´s entropy, Hausdorff´s dimension.

Vlasov-Fokker-Planck description of the magneto-optical trap

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The magneto-optical trap (MOT) is the primary tool to cool atoms. The development of this technique led to spectacular breakthroughs in experimental quantum physics, such as optical lattices, cold molecules, or Bose-Einstein condensates. But the MOT is a complex object, as spatio-temporal instabilities of this cloud are commonly observed. Several models with different approaches

have been proposed to describe these dynamics, and to identify the mechanisms leading to instabilities. Unfortunately, none of these models gives a satisfying description of the observed dynamics.
Recently, it has been proposed to describe the MOT as a weakly damped plasma. Indeed, the cloud of cold atoms in a MOT is a confined dilute object with long-range interactions, as in plasmas. This model predicted the existence of instabilities above a relatively high threshold, so that instabilities should exist only in large MOTs. This seems in contradiction with the observations related in the literature. Moreover, no direct comparison with the experimental temporal regimes allowed validating this model. More recently, a more complete description was derived using the methods of waves and oscillations in plasmas, leading to interesting predictions. But as in the previous case, this study is based upon intermediate well-established results, valid only in specific cases, not corresponding in general to the experimental situations. It appears from these numerous works that a reference model for MOT atom clouds lacks. Such a model could help in determining precisely the analog! ies between MOT atom clouds and other systems, such as plasmas.
We present here such an exhaustive kinetic model for the atoms in a 1D MOT. We show that the atomic density is described by a Vlasov-Fokker-Planck equation, coupled with two simple differential equations describing the trap beam propagation. The analogy of such a system with plasmas is discussed. We show that such a trap is described by a Vlasov-Fokker-Planck equation with a second relaxation term and a source term, both originating in the bath of hot atoms of the atomic vapor. This VFP equation is coupled to a set of two differential equations describing the beam propagation in the cold atoms. This system could be considered as relatively similar to plasmas, where the role of the thermal bath is played by the trapping beams. However, it appears that the MOT differs from plasmas on two important points: the second thermal bath, formed by the hot atoms, induces new interactions as compared to plasmas; the trapping beams are not a “thermal” bath, as the atoms act on them through the absorption.

Evidence of Deterministic Behavior in the Financial Markets: Classification of Underlying Dynamics

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This work aims to find evidence of deterministic dynamics in Financial Markets combining the advanced spectral method of the Singular-Spectrum Analysis (SSA; Broomhead and King 1986) with the classical tools provided in the chaos theory.
We focus on return and realized volatility series of several stock indexes (i.e., FTSE ITALIA MIB STORICO, DAX 30, CAC 40, FTSE ALL SHARE, S&P500, NIKKEI ALL STOCKS and EURO STOXX). Initially, we decompose the time series by using the SSA approach. This method is useful to separate the

components of time series into a relative small number of interpretable and independent components such as oscillatory components, seasonality and 'structureless' noise.
Then, we reconstruct the original time series by using a number of selected eigenvalues.
Despite the extremely complex morphologies observed in the vast majority of the Financial Markets time series, here we show that the fundamental dynamic appears to be governed by a well-defined fractal attractor.
A universal strange attractor, underlying the nontrivial financial time-structures, suggests that the mechanism of production of such phenomena is governed by some inherent deterministic processes with a few degrees of freedom.
Keywords: Singular Spectrum Analysis, Economy

Toward a reliable use of the nonlinearity detection and the noise titration technique

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Even if noise titration cannot be used to prove the presence of chaos, it can still be used to detect nonlinear component in dynamics. Nevertheless, since the technique is based on nonlinear models for one-step-ahead predictions, it requires an acute choice of modelling parameters, that is the number of terms and the nonlinearity degree of the models. Based on illustrative examples, we propose conditions under which the noise titration can be reliably applied to characterize nonlinearity governing the dynamics underlying the measured time series. Moreover, we found that investigating nonlinear dynamics in the entire phase space or in a Poincaré section does not necessarily lead to similar results.
Keywords: noise titration technique, time series analysis.

"Quantum" Chaos and Stability Condition of Soliton-like Waves of Nuclear Burning in Neutron-Multiplicating Media

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We show that the stability condition for the soliton-like wave of nuclear burning in neutron-multiplicating medium is determined in general by two conditions. The first condition (necessary) is determined by relationship between the equilibrium concentration and critical concentration of active (fissile) isotope, which is a consequence of the Bohr-Sommerfeld quantization condition. The second condition (sufficient) is set by the so-called Wigner quantum statistics, or more accurately, by a statistics of the Gaussian simplectic ensembles with

respect to the parameter that describes the squared width of burning wave front of nuclear fuel active component.

Keywords: soliton-like; wave; nuclear burning; neutron-multiplicating medium; Wigner quantum statistics

PACS number(s): 25.85.Ec; 28.50.-k; 05.45.Mt; 05.45.Yv

Random matrix theory and quantum chaos in weakly-disordered graphene nanoakes

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Statistical distribution of energy levels for Dirac fermions confined in a quantum dot is studiednumerically on the examples of triangular and hexagonal graphene flakes with random electrostatic potential landscape. When increasing the disorder strength, level distribution evolves from Poissonian to Wigner, indicating the transition to quantum chaos. The unitary ensemble (with the twofold valley degeneracy) is observed for triangular flakes with zizgag or Klein edges and potential varying smoothly on the scale of atomic separation. For small number of edge defects, the unitary-to-orthogonal symmetry transition is found at zero magnetic field. Otherwise, the orthogonal ensemble appears. These findings are rationalized by means of additive random-matrix models for the casesof weak and strong intervalley scattering of charge carriers in graphene. Electromagnetic propertiesof an ensemble of such regular graphene flakes are also briefly discussed.

Optimization of programs of interrogation of sensors in digital control systems

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The object of the control can have the big number of sensors. The information from sensors is consistently entered into a digital control system. Sensors essentially differ demanded frequencies of time digitization. The program of interrogation of sensors should provide a necessary error of restoration of signals and minimize redundancy of the entered information. In the report statement of a question is considered and the algorithm of formation of the optimum program of interrogation is offered.

Keywords: digital control systems, sensor, program of interrogation, frequencies of digitization

Period adding model of the bubble formation dynamics

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We have studied the air bubble dynamics formation in nozzles placed at the bottom of a cylindrical acrylic tube containing a water/glycerol solution. The nozzles are metallic needles with radius D= 0.2, 0.5, 1.2 and 2 mm, and length h=2.9 cm. The nozzle is connected to the air reservoir through an air flux controller with hoses of different lengths L=50, 85,140, 180, 212, 250 and 302 cm.
The bifurcation diagrams were constructed by measuring the time between successive bubbles letting the air flow vary in the range [40, 200] ml/min. Such delay times were measured with a laser photo-sensor system by detecting the pulses induced when the bubbles cross the light beam.
We observed bifurcations which are period adding cascades rising the periodicity of successive periodic windows, with increments of one unity, until a maximum period value before a collapsing in a final period one window. Such cascades depend of the needle radius and bigger the hose length bigger the maximum period observed.
For some fixed air flow values, additional insights of the air bubble formation were obtained by recording images of air bubble profiles with a high speed camera and also observing the pressure wave in the hose connection by using a microphone placed below the needle system.
Therefore, we were able to develop a model based on physical principles, including added mass, which reproduces the period adding cascades. The model also explains the role of the hose length and the nozzle radius, which are essential parameters, showing the existence of a needle radius critical value above which the adding cascades are not present.
This work was supported by the Brazilian agencies FAPESP and CNPq.
Keywords: Period adding bifurcation, bubble formation

Buoyantly Unstable Three-Dimensional Chemical Fronts under an Influence of a Liquid Layer Depth

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Chemically induced hydrodynamic instabilities were observed in liquid systems, where iodate-arsenous acid (IAA) reaction fronts propagated. Vertically oriented IAA reaction fronts are in liquid systems buoyantly unstable due to fact that products are lighter than reactants. The presented experiments were performed in a channel reactor with a rectangular cross-section, where top of reaction solutions was open to air. An influence of the liquid layer depth on velocities and shapes of IAA reaction fronts is shown. An influence of the meniscus deformation on the front propagation is discussed.

Keywords: Chemo-Hydrodynamic Instabilities, Pattern Formation, Chemical Fonts, IAA Reaction, Buoyancy, Meniscus

A General Systems Theory for Atmospheric Flows and Atmospheric Aerosol Size Distribution

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Atmospheric flows exhibit selfsimilar fractal spacetime fluctuations manifested as the fractal geometry to global cloud cover pattern and inverse power law form for power spectra of meteorological parameters. Inverse power law form for power spectra indicate long-range spacetime correlations or non-local connections and is a signature of selforganised criticality generic to dynamical systems. The author has developed a general systems theory which predicts the observed selforganised criticality as a signature of quantumlike chaos in dynamical systems. The model predictions are (i) The probability distribution represents the power (variance) spectrum for fractal fluctuations and follows universal inverse power law form incorporating the golden mean. Such a result that the additive amplitudes of eddies when squared represent probability distribution is observed in the subatomic dynamics of quantum systems such as the electron or photon. Therefore the irregular or unpredictable fractal fluctuations exhibit quantumlike chaos. (ii) Atmospheric aerosols are held in suspension by the vertical velocity distribution (spectrum). The atmospheric aerosol size spectrum is derived in terms of the universal inverse power law characterizing atmospheric eddy energy spectrum. Model predicted spectrum is in agreement with the following two experimentally determined atmospheric aerosol data sets, (i) SAFARI 2000 CV-580 Aerosol Data, Dry Season 2000 (CARG) (ii) World Data Centre Aerosols data sets for the three stations Ny Alesund, Pallas and Hohenpeissenberg.
Keywords: universal atmospheric aerosol size spectrum, SAFARI 2000 aerosol size spectra

Chaotic Modeling of Intellect

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The chromatic approaches to the information processing enabled to represent an archetype as a psychophysical formation that had been canonized by world cultures in the process of thousand of years and on the basis of which the archetypal model of intellect (AMI) of the atomic type was obtained. The link between the dominant character of “atomic” components in the AMI and choice of preferred colors was confirmed experimentally. Primary concordance with the

experiment enabled to consider the established principles of AMI to be the basis for color simulation of gender aspects of a personality.
We have shown that “atomic” components in the AMI-system (*M*-, *Id*-, *S*-plans) are linked with relevant parameters of a color concept in psychophysics, chromatism, psycholinguistics, and informatics in tabl.3.Triad logic of a complex information system may be actually revealed only if we take into account the boundary that separates, and at the same time, combines complementary colors λ_2 and $\lambda_1$of the components, forming this system λ_0. The principles, established for the AMI, become the basis for digital representation of all stages for color information processing from spectral components of the outer environment to the forming of a color concept.

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Nonlinear vibrations and chaos in electrostatic torsional actuators

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Electrostatic torsional micro-mirrors have wide spread use in different industries for diverse purposes. This paper investigates the development of superharmonics and chaotic responses in electrostatic torsional micro-mirrors near pull-in condition. Appearance of nonlinear phenomena is investigated in models accounting for and disregarding coupling of torsional and flexural deflections. Analysis of the system response to step and harmonic excitation reveals the appearance of DC and AC symmetry breaking. Increasing the amplitude of harmonic excitation the response in the form of distinct superharmonics changes to a broadband response, where there is loss of periodicity and the response becomes chaotic. Accounting for flexural deflections in coupled model reduces the voltage thresholds corresponding to symmetry

breaking and chaotic responses. It is also shown that damping has a regularizing effect and introduction of damping changes the chaotic undamped response into quasi-periodic one.

Keywords: chaotic vibrations, Micro mirror, electrostatic actuation

Simulation and Control of Highly Maneuverable Aircraft under Turbulent Atmosphere using Nonlinear Dynamics Inversion Technique

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This paper presents a robust technique to design the flight controllers for the aircraft to fly under turbulent atmosphere as well as to perform maneuvers incorporating the whole highly nonlinear dynamics of the aircraft system. Aircrafts have a number of degrees of freedom (DOF) and so translational as well as rotational motion can be performed by the aircrafts in all those directions of freedom. Aircraft flight controller is required for the aircraft to undergo various flight conditions and to perform various types of maneuvers in a desired and controlled manner. In this study, completely nonlinear set of equations defining whole dynamics of the aircraft have been used for simulation and Nonlinear Dynamics Inversion (NDI) control technique has been used to design the controller of the flight vehicle. NDI control technique is a highly emerging time domain control methodology used to design the controllers for various types of highly nonlinear systems.

Keywords: Nonlinear dynamics inversion (NDI), Aircraft flight controller, Flight envelope.

Effect of entrainment in a chain of reactively coupled self-oscillators

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We consider a chain of reactively coupled [1] self-sustained oscillators with a frequency gradient across the oscillators chain. The emission spectra and response of the system to the quasiperiodic external signal in the presence of noise and without noise is investigated.

Keywords: Chaotic synchronization, nonlinear oscillators

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Painting chaos: universality of parameter patterns of systems with the Lorenz attractor

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Bi-parameter screening based on a symbolic approach reveals fine structures and richness of universal patterns of the strange chaotic attractor in three exemplary systems: the classical Lorenz model, a mathematical normal form, and a laser model from nonlinear optics. The patterns are orchestrated by the so-called Terminal (T) points that are hidden centers of the global organization in the parameter space of the Lorenz attractor.

Keywords: kneading, symbolic dynamics, Lorenz attractor

Proven complex dynamics of software engineering

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Before making effort to analyze systems, we should identify the exact type of system and determine that we consider our system in which categories of systems. Rapid changes in technology are created the double problems in the field of planning and organizing the structure of manufacturing software engineering projects. Detailed industry estimates is impractical for preparing a software application. In such an environment, a new way of thinking is required. Introduction of complex systems is discussed here as alternatives to plan and deal with these changes. Order in complex systems is not because a targeted behavior of the system elements or influence a central organization management. Regular patterns in this system are an example of Self-Organized. In this article, software engineering is proven as a nonlinear complex system and continues to review the components and features Self-Organized in software engineering. After demonstrating the software production process among the complex systems, we can use complexity theory and techniques relating to building complex systems for more accurate understanding of the process and prevented impact of inappropriate nonlinear to cost, function, relationship and program features.

Keywords: Software engineering, Complex system, Dynamic, Self-Organized Criticality, Process model, Life cycle.

Design of the software process model in accordance with standard of the chaos model

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Software engineering is known as a problem solving activity and modeling. All the principles in software engineering are emphasized on the conditions for software producers are unpredictable because of the interactions and mutual relationships between all the factors involved in creating and those conditions never allow full control over this process. Since the emergence of software engineering processes, models and processes focus on reducing non-forecasting in the process model due to provide available software in a certain period with predicted cost, but it cannot be out of this complexity, and the simplicity would not lead by imposing a simple model to process model. The aim of this paper is design of a software process based on chaos theory.
In this article, software production process assumed as a nonlinear dynamic process, and hence it is located in the ordination complex systems. It would continue with using chaos techniques to analyze software production process and fractal structure of process models is presented. In particular, preparation of a model based on chaos theory can show close relationships between many of the facts contained in software development and reflect complex patterns that occur during the project, with a help of flexible and variable fractal structure.
Keywords: Software engineering, Chaos theory, Process model, Fractal, Problem

Chaotic Oscillations Of Nonideal Flat Pendulum Systems

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The oscillations of a flat pendulum, the suspension point of which excites by electric motor of the limited power are considered. Mathematical model for such systems has been constructed in [1]. In parameters space of system "pendulum - electric motor", the atlas of maps of dynamical regimes, which gives exhaustive information about systems attractors is constructed. The fact that the deterministic chaos is a typical steady state regime of the given system is established. Phase portraits, bifurcation trees, Poincare sections and maps of the examined system are constructed and thoroughly examined. The class of Feigenbaum's universality of the given system is defined. The qualitative similarity of dynamic behavior of the examined continuous system and discrete logistic map is shown. Furthermore, in some cases the dynamics of this system can be approximated by a onedimensional discrete map. Analytical representation of such onedimensional discrete map is obtained.
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Keywords: nonideal system, chaotic

Peculiarities Of Transition To Chaos In Nonideal Hydrodynamics Systems

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Low dimensional mathematical models of nonideal hydrodynamic systems of type «tank with a liquid - electric motor» are investigated. An exclusive variety of chaotic dynamics of such systems is established. It is shown that nonideality of systems is one of principal causes of origin of chaos.
The atlas of maps of dynamic regimes of systems «tank with a liquid - electric motor» is constructed. Various types of chaotic and hyperchaotic attractors of the considered systems are analysed in details. Scenarios of transitions of type «chaos - chaos», which generalizes known scenarios of Pomeau – Manneville and Feigenbaum are revealed.
Keywords: chaotic attractor, map of dynamic regimes, scenario of transition to chaos.
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Informational Technologies for Quasilinear Research of Stochastic and Chaotic Systems

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1. It is known [1, 2] modern modeling (analytical, statistical and combined) and estimation (filtering, extrapolation, interpolation, parameters identification) informational technologies (IT) for nonlinear stochastic systems (StS) are based on off-line and on-line information. For engineering applications there are successfully used quasilinear methods based on equivalent linearization techniques (ELT) for solving equations (Eqs) for probability densities. Experimental results received in IPIRAN for chaotic systems (ChS) research IT show that these ELT may be used. But ELT for ChS need some development.

2. For off-line information analytical modeling of ChS with small Gaussian perturbations based on Fokker-Plank- Kolmogorov Eq, Feller-Kolmogorov Eq for poisson perturbations and Pugachev-Sinitsyn Eq – for perturbations being the derivative of stochastic process with independent increments need to solve singular Eqs. The solution of these Eqs is very difficult for nowadays computers as for on-line and off-line information.

According to ELT one linearize the right hand of given stochastic differential Eq (in Ito sense) and implement known Pugachev-Dunkan ordinary deterministic Eqs for mathematical expectation, covariance matrix and matrix of covariance functions at corresponding initial conditions. The coefficients of these Eqs due to nonlinearity depend on mathematical expectation and covariance matrix. So these Eqs are interconnected and need joint solution.

For robust ELT it is quite enough to suppose the Gaussian law for density of input signal for nonlinear element and use known formulae of statistical linearization for typical scalar and vector nonlinear functions [1, 2].

When the stochastic input signal contains the harmonic component one use combined harmonic and statistical linearization [2].

For input signal given by canonical expansion (CE) we develop corresponding ELT based on [2] and symbolic calculations [3, 4]. IT based on CE ELT are effective as for analytical, statistical and combined modeling (simulation).

3. For on-line information optimal nonlinear estimation in ChS with small stochastic perturbations is based on Kushner-Stratonovich Eq for conditional density or corresponding Eq for conditional characteristic function. These Eqs are very difficult for solution on nowadays computers even for simple models [1, 2, 5].

According to robust ELT based on Gaussian density one may use Kalman-Bucy Eqs with coefficients depending on mathematical expectation and covariance matrix.

For input signal of nonlinear element containing harmonic component one may use combined harmonic and statistical linearization [1, 5].

When the input signal of the nonlinear element is described by CE we develop corresponding ELT based on [2] and symbolic methods [3, 4].

The discussed ELT where realized in line of modern software tools developed in MATLAB.

Applications: statistical and chaotical vibromechanics, fluctuations of the Earth Pole and irregular rotation of the Earth.

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How Natural System Anticipates Emotion Recognition

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In this research paper we hypothesize the human facial emotions recognition (FER) process is related to gaze "jumping" and to emotional level of observer itself. Evolutionary speaking it's vitally important to recognize emotions quickly and precisely in order to evaluate the situation and react to it adequately.
We suppose that facial emotion recognition is a process of convergence of induced neural zones into one of many local attractors, which represent mental models or behavioral schemes as a reaction to certain emotions. The convergence speed is growing if visual FER part ("data collection") is leaded by gaze fluctuations between emotion' representing segments (for example, facial parts). The higher uncertainty of visage is, the bigger gaze fluctuations there are. In the case of factitious emotional expressions, FER is more difficult if observer is better trained and gaze "jumping" is minimal. Gaze "jumping" in nonstandard situations of untrained person (like a child) grows independently if it leads or not to only attractor (i.e. the emotion is recognized or is not recognized). Consequently the gaze "drifting" is related to experience and training, but an increased gaze fluctuations means transition from one local attractor to another improving FER process. Therefore learned emotions serves to recognize better the other emotions, by increased gaze „drifting" - emotions participate as catalyst of recognition process. Also asymmetry evokes gaze fluctuations and even a small one anticipates recognition process.
During the experiment (unnatural facial emotions recognition) with children, gaze "jumping" is higher even if any decision follows from that. Meanwhile gaze oscillations of adults are smaller and lead to certain identification cluster (even misguided).
Keywords: facial emotion recognition (FER), mental model, dynamical system, modeling

Stochastic Modeling of Life Table Data: Recent Findings

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Stochastic modeling of life table data is growing during last decades following the work of Strehler and Mildvan published in Science (1960) and the advancement of the stochastic theory and especially the modeling of the first exit time or hitting time process. The stochastic modeling provides new tools in the related scientific field thus making better fitting to the data and more reliable

predictions in terms of life expectancy and other characteristic futures. This talk summarizes the related findings while providing examples and applications.

Keywords: Life expectancy, Stochastic modeling, Life table data.

Classification of the methods of simulation for various applications

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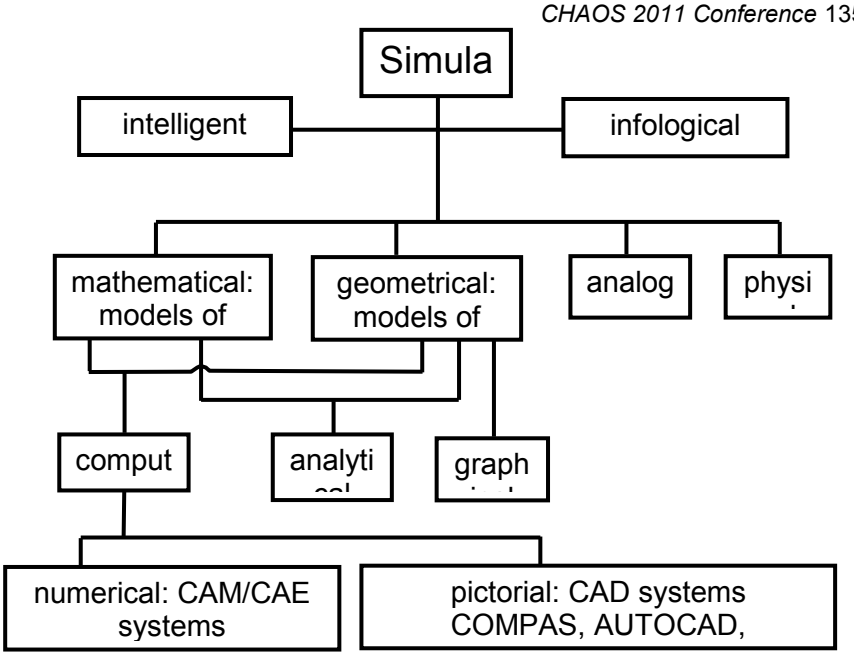
Simulation of processes and objects allows us to solve various applied problems:

1. The elaboration of expert systems, capable of giving advices in extreme or difficult situations.
2. The creation of databanks for storing information about variants of simulation.
3. The creation of digital libraries.
4. The application of mathematic modeling (analytical, numerical, graphical) for making models of processes.
5. The application of CAD systems for computer simulation of objects.
6. The application of CAM/CAE systems for computer simulation of processes.
7. The analogue simulation of complex problems to show the clearness of their solution.
8. The physical simulation of processes for checking up the results.

The problems posed can be solved by applying different methods of simulation. The subdivision into the methods are rather conventional.



Intelligence Simulation it is based on making thinking models (the cybernetics of «a black box»); it is used to solve ill-defined problems, for which it is difficult to make up algorithms; it serves as the basis for creating expert systems.

The core of any expert system is a knowledge base. In knowledge base the information units (attainments) are represented in the form of models. The models allow to structure knowledge.

One can single out three basic models of knowledge representation: a productional model, a semantic network, frames.

Infological simulation it is used to solve information problems; separate modules are the information units joined into a single logical net; it is used in database management systems, e.g. Access, to create data schemes which represent infological modules (tables) joined into one chain by means of fields.

First-level kinds of simulation are used to solve ill-structured and infological tasks. In order to solve structured tasks are used methods of simulation second-level: numerical, graphical, analogue and physical.

The most productive and powerful method of simulation is by far the computer simulation, which combines numerical and graphical methods

All the modes of computer simulation can be conventionally divided into two categories: the modes of processes simulation (MPS) and the modes of objects simulation (MOS).

The MPS may include CAM/CAE and other systems, which allow to model the process in a particular data domain. Such programs are called applications. These are DEFORM, FORGE, ANSYS, SPLEN and others.

The MOS include CAD systems, which allow to model geometrical objects (from primitives to complex curvilinear surfaces). Besides, such systems enable to project complex machinery and prepare design documentation for

them. The examples of such CAD systems are COMPAS, SolidWorks, Unigraphics

It is evident that the efficiency of each applied mode depends upon the specific aspect of the given problem.

Chaos On A Simple Rational Planar Map

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The dynamics of a 2-D rational map are studied for various values of it's control parameters. Despite it's simple structure this model is very rich in non-linear phenomena such as, multi-scroll strange attractors, transitions to chaos via period doubling bifurcations, quasi-periodicity as well as intermittency, interior crisis, hyper-chaos etc. In this work, strange attractors, bifurcation diagrams, periodic windows, invariant characteristics are investigated both analytically and numerically.
Keywords: 2-D nonlinear maps, Chaos, Quasiperiodicity, Hyperchaos.

About Principles of creating of the structured particles mechanics

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The principles of creation of the mechanics of structured particles are considered. The explanation how this mechanics leads to the account of dissipative forces is offered. The explanation of a motion equation for the system consisting from the potentially interacting material points is submitted. It is discussed why the motions of the system determine by two type of symmetry: symmetry of the system and symmetry of space and how it leads to two types of energy and forces accordingly. It is shown how the mechanics of the structured particles leads to thermodynamics, statistical physics and kinetics.
Keywords: Dynamics, irreversibility, Hamilton formalism, classical mechanics, entropy.

Bifurcation of Generalized Logistic Maps

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The bifurcation of generalized logistic iterative maps is examined as a necessary condition for the existence of a chaotic resulting behavior**.** The iterative maps under consideration are of the form $x_{n+1} = r\, x_n^{\lambda}(1-x_n)^{\mu}$ with the

parameters r, λ and μ being positive real numbers, and the variable x as well as its map ranging from 0 to 1, the latter yielding the upper limiting value of r for which full chaos is obtained if it exists. The values of λ and μ determine the variations of the resulting x's which can have totally different characteristics from those of the classical logistic map, given by λ = μ =1. In the present paper focus is on the existence of the first bifurcation of the above maps. In particular, surfaces of the parameters r, λ and μ are found analytically which separate bifurcating from non-bifurcating iterative maps. For some of the maps, the bifurcation points are derived in explicit algebraic form. Furthermore, for iterative maps near them whose bifurcation points cannot be obtained exactly, they are obtained approximately using Newton's method one step away from the exact bifurcation points of their neighboring maps.
Keywords: bifurcation points, chaotic maps**,** logistic maps**,** iterative maps, recurrence equations

The Music of a Chaotic Sound Machine

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A chaotic sound machine is created by two inter-connected individual sound makers. Each of the sound makers produces by itself a chaotic sequence of sounds. Its connection with the other sound maker modifies and enriches the quality characteristics of the individually produced chaotic sounds. The choice of the individual sound maker is in general arbitrary as is the communication pattern (switching on and off) between the two sound makers. In the present study, the chaotic waveforms of each sound maker are generated algorithmically by utilizing different first order iterative maps with such parameters that yield chaos. For every set of two iterative maps, a different chaotic sound machine is made. The machine's sound characteristics also depend strongly on when each of the sound makers is on. This effect is also examined by considering different communication patterns between the sound makers of the machine. The sounds produced algorithmically in the time domain for different sound machines are compared as is their energy. Discrete Fourier transform is then employed to compute the sounds' power spectral density over frequency revealing the location and relative loudness of the partial overtones which are associated with the fundamental frequencies of musical notes. The onset of the partial overtones is obtained from the sounds' frequency dependent phase. It is found that the quality of music of the generated sounds changes dramatically between different sound machines but also within the same machine.
Keywords: Sound machine, sound synthesis, sound spectrum, chaotic sound, sound analysis, power density, partials, overtones, music timbre, algorithmic music, chaotic music

A Narrative for Chaotic Octet

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A narrative for chaotic octet is presented in essentially four parts. Various processes for different parameters appear in each part. In the introduction, instrumentation is dictated by a random walk. In the first part, stochastic distribution dictates time-points for certain sections within the part. A transition (juxtaposition) section occurs where elements from the second part are first being presented. Stochastic distribution is also a factor in this section where the discrete results represent the points depending on whether the first or second part elements are playing. Finally, the second part includes a freely constructed attractor, where, a dominant line is occurring and various similar lines gravitating around this dominant line gradually *end* in unison with the dominant line. Examples of resulting octets are presented in musical notation and their recordings are played for the conference audience.
Keywords: musical instrumentation, octet, music composition, algorithmic music, chaotic music, stochastic music

Dynamics of oscillators with limited power supply

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The dynamics of oscillators with limited power supply (also called non-ideal oscillators) are investigated. To characterize the dynamics of oscillators, we use the largest Lyapunov exponents identifying, in a two-dimensional parameter space diagram, selfsimilar periodic sets such as resonance tongues and shrimps-shaped structures. As non-ideal oscillators, we consider a cart, driving by a pendulum, connected to a fixed frame by a nonlinear spring and a dash-pot.
Keywords: Non-ideal Oscillators, Shrimps, Resonance Tongues.
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Analysis of multichannel EEG data by nonlinear dynamics methods

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The experimental EEG data recorded from real patients of Rostov medical University Clinic was investigated from the point of view of non-linear dynamics. Standard EEG abstractions "10-20" data were collected and

processed by the special software. Nonlinear invariants were calculated for different deceases and healthy persons. Correlation dimension and Lyapunov spectrum can be used as informative features.
Keywords: nonlinear dynamics, EEG data, invariants

The research of phase transformations order-disorder in CuAu and Cu Pt alloys of equiatomic compositions

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The group of ordering alloys suffering the number of definite external conditions (temperature, pressure): phase transformations order-disorder-order are determined by their physical and physics-mechanical properties among the other alloys. The change of atomic and magnetic order is typical for such materials. Phase transitions can be accompanied by the change of a basic crystal structure. Phase transitions order-disorder having equiatomic compositions are studied by Monte-Carlo method on the example of Cu-Au and Cu-Pt. The first alloy undergoes structural change of FCC – FCT lattice in the process of ordering. The second transition is FCC - rhombohedric crystal lattice.
The superstructures formed during the ordering are marked as L10 and L11. They are characterized by the alternation of monoatomic planes in directions <001> and <111>. It was shown in the computer experiment that order in the alloys corresponding to superstructures L10 and L12 can be reached at the definite intervals of temperatures and deformations of uniaxial tension (pressure) along directions <101> or <111>. The antiphase domains of both types of superstructures can be formed in the ordering processes.
Keywords: Monte-Carlo, phase transformations, order, disorder, superstructure, crystal.

Transfer Operators from a Orthogonal Polynomial Point of View

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Transfer operators, e.g. the Ruelle-Perron-Frobenius operator, have long been a standard tool in dynamical systems. Rather recently, transfer operators have been used to shed new light on wavelet theoretical questions such as the calculation of orthogonal wavelet basis. Based on these results and using orthogonal polynomial techniques, we can show interesting new aspects of transfer operators on various spaces and in different contexts.
Keywords: Transfer Operator, Ruelle-Perron-Frobenius Operator, Dynamical Systems, Orthogonal Polynomials, Harmonic Analysis.

Modeling of nitriding process with the stochastic changes of diffusion coefficient

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The gas nitriding process is a key thermo-chemical diffusion treatment, which improves mechanical properties of tools and machine parts. The control variables of a process can be for example: time of nitriding, nitrogen potential or process temperature. It can be proved that by controlling the values of those variables the expected thickness and the structure of nitriding layer can be obtained. To get a full information about dynamic of a process the influence of the form of boundary conditions on the modeled process must be examinated. To receive a model which better describes a real nitriding process the stochastic changes in the value of nitrogen flux, caused by surface imperfection and chemical reactions on the surface and inside of material were taken into consideration.
In the paper the results of nitrogen concentration distribution as a function of space-time variables in the nitrided material, including stochastic changes of diffusion coefficient, caused by heterogeneity of nitrided material structure, were also presented.
The effects of stochastic perturbations of the value of nitrogen flux on the dynamic and distribution of nitrogen concentrations in the surface layer of the tool during the nitriding process, with a fixed form of the function modeling the diffusion coefficient were shown.
Keywords: nitriding process, FEM simulations, mathematical modeling, nitrogen diffusion

Modeling of the stresses evolution in multilayer PVD coating

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In the paper physical and mathematical models describing the dynamics of the stresses fields in the knife for the wood treatment, covered with antiwear, multilayer coating was presented. Description of a time evolution of stresses fields in layers during PVD covering process has a great importance in computer aided design of antiwear coatings.
In the paper, the necessity of including transition layers occurring between the layers of the multilayer coating, and between the steel base and first coated layer was postulated. This was achieved through the modeling of the transitional layer by transfer function describing changes of material parameters values from one layer in to another. To receive a model which better describes a real PVD coating process, the stochastic perturbations of material parameters values in the layers, caused by heterogeneity of materials structure were taken into consideration.

Functional dependence describing the relationship between the parameters values of a transfer function and the shape of the stress field occurring in the transition layers after PVD covering process was also determined.
Keywords: Von Mises stresses, FEM simulations, multilayer coatings, thermal stresses

Nonlinear Vibrations and Chaos in Floating Roofs

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Hamilton's variational principle is used to derive the nonlinear response of floating roofs of cylindrical liquid storage tanks due to harmonic base excitations. The contained liquid is assumed incompressible and inviscid. The variational principle accounts for nonlinearity caused by large deflections of the floating roofs. Derived nonlinear ordinary differential equations has cubic nonlinear stiffness terms similar to Duffing equation. Due to small damping of the fluids, storage tanks are subjected to the resonance in the case of coincidence of natural frequency with excitation one. It is shown that accounting for large deflections of the roof plate, reduces the height of sloshing induced surface waves. Evaluating the response of nonlinear model for increasing amplitude of harmonic excitations, gives rise to the appearance of sub and super harmonics in the response. Further increase of excitation amplitude increases the contribution of sub and superharmonics in the response and for some excitation amplitudes the response become chaotic. Fractal structure of the Poincare maps is the evidence of the chaotic responses.
Keywords: Floating roof, variational principle, large deflection, sloshing.

Parametric and Autoparametric Chaotic Systems

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In this paper, we present some recent study and simulation results relating to a class of chaotic systems proposed in [1]. Parametric and autoparametric chaotic systems belong to time-variable ones, and they can be designed on the basis of any time-invariant chaotic prototype with lamped (not distributed) parameters, for example, Chua's, Lorentz, Rossler's, etc. In the discussed systems, all of the coefficients are controlled simultaneously by means of the applied parametric action, which is an arbitrary positive scalar function, external or internal one. In the latter case, the action should be an arbitrary positive function of system state variables.
Parametric and autoparametric systems generate more complex dynamic chaos (as compared to the prototype) which is easily controllable (programmable) in a wide range by variation of the parametric action magnitude and shape. It results in considerably expanded functionality for various applications, first of all – for

secure communication systems. Design considerations and simulation results are presented.

Keywords: Dynamic chaos, Parametric chaotic systems, Autoparametric chaotic systems, Chaos control.

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Communications on Parametric Chaotic Carrier

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Secure communications on chaotic carrier present one of the most important fields for the dynamic chaos application, because chaotic signals are noise-like, broadband, and difficult to predict. In this paper, we present some ideas on the utilization of parametric chaos benefits to improve the degree of security in such systems.

We prove that both parametric and autoparametric systems, like their time-invariable prototypes, are able for self-synchronization and mutual synchronization. Moreover, they provide considerably expanded opportunities for transmitting signals which have wide dynamic range. One more advantage of parametric chaotic systems for communication is the possibility of creating nested multilevel hyperchaotic systems. This idea is based on using a signal, which is generated by another chaotic system, as a parametric action for driving chaotic carrier to be transmitted. The results of computer simulations are presented.

Keywords: Dynamic chaos, Secure communications, Parametric chaotic systems, Chaos synchronization.

Bifurcation processes in the literature: from chaos to self-organizing

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The mechanism of a birth of a new (innovative) genre, one of the most complex mechanisms in literary process. There are various hypotheses of birth and existence new (innovative) genres. But this mechanism up to the end is not analyzed to this day. To many authors it sees as chaotic, not having laws. The author of the given work shows, how the phenomenon bifurcation participates in the given process. In fact actually, all constructed for various transitive systems bifurcation diagrams are arranged qualitatively equally. Unique distinction consists in terminology which owing to specificity of each considered problem is concrete transitive system necessary for the description. G.Nikolis and I.Prigogine consider the given mechanism, resulting as examples of Bernard'

cell, Belousov-Jhabotinsky' reaction, etc. However they suppose an idea that it is possible to consider as also the mechanism, for example, behavior of group of our ancestors, gathering to accept ideographic or symbolical writing. Therefore it is possible to approve, that transition to new is closely connected with the advent of new branches of the decision as a result of bifurcation, in fact all this occurs owing to the loss of stability of the standard condition caused nonlinearities and external restrictions in open system. The system of literary genres is opening, self-organization system. And a source of innovations in the given system is bifurcation as owing to it in system of genres of any literary sort there is a new decision.
Keywords: self-organization system, chaos, bifurcation, an innovative genre

The Chaotic Sandwheel

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The Lorenz system is a theoretic example of a chaotic system, and resulting Lorenz butterfly a classic image in nonlinear dynamics. The (chaotic) Malkus waterwheel was developed as a phys- ical demonstration of the somewhat abstract Lorenz system. Several authors have studied the many physical and mathematical details Malkus waterwheel, although none appear to consider media other than water. In this paper we present the chaotic sandwheel as an alternative pseudo- Lorenzian system. Although the change from water to sand seems minor in the original equations, its consequences in the subsequent derivation bring us to a system that, while losing some features, retains the essence of Lorenzian dynamics. We show that the order-chaos-order transitions for the waterwheel and sandwheel are significantly different. Numerics also suggest new questions about Lorenzian systems.

Synchronization in Kuramoto Model with Distance-dependent Delay

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The popular Kuramoto model of mutual synchronization of coupled oscillators [1] has, since its inception, drastically improved the understanding of this prevalent phenomenon. Common examples include synchronous chirping of crickets, ashing of Chinese _reies, clapping of audiences, bursting of neurons, contraction of heart muscles or operation of Josephson junction arrays to name a few (*see e.g.* [2]). This model still remains the most successful one, due to its tractability, combined with the ability to capture the essence of synchrony. In this work we investigate the coherent and incoherent phases in a generalized Kuramoto model of phase-coupled oscillators with distance-dependent delay. Preserving the topology of a complete graph, we arrange the nodes on a square lattice while introducing finite interaction velocity, which gives rise to non-uniform

delay. It is found that such delay facilitates incoherence and removes reentrant behavior found in models with uniform delay [3]. A coupling-delay phase diagram is obtained and compared with previous results for uniform delay.

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Keywords: Generalized Kuramoto model, distance and velocity dependent interactions, synchronization.

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Chaotic behavior of seismicity induced by fluid injectons

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Problem of passive seismic monitoring data interpretation was considered. Ideas and methods developed in the theory of dynamical systems and chaos were used for analysis of production-related seismicity at Romashkino oil-field (Russia), and data of laboratory experiments on acoustic emission due to pore pressure increase. Phase portraits of the seismic activity and efficiency of water injection were constructed. Attractor dimensionality and phase space dimensionality were estimated with the help of Grassberger & Procaccia method. It was found, that seismicity induced by water injection for oil recovery posses an attractor of dimensionality less than 2.7. It was shown based on laboratory data interpretation, that one can expect a decrease in dimensionality of the attractor with decrease of the porous medium permeability.

Keywords. Non-linear dynamics, seismicity, induced seismicity

Adaptive Backstepping Neural Network Control for Mechanical Pumps

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In this paper, an Adaptive Backstepping Neural Network control approach is used for a class of affine nonlinear systems which describe the

pump model in the strict feedback form. The close loop signals are semi globally uniformly ultimately bounded and the output of the system is proven to follow a desired trajectory. Simulation results are presented to show the effectiveness of the approach proposed in order to control the pump output.

Adaptive Control of Mixed-Interlaced forms

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In this paper we combine forwarding and backstepping techniques to stabilize mixed interlaced systems. All the signals in the close loop remain semiglobally ultimately bounded the output signal y follows a desired trajectory signal y_d, with bounded derivatives up to m^{th} order. We also present simulation examples that prove the adaptation of mixed interlaced forms, using a backstepping controller.

Linear-inversive congruential generator of PRN's

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Generalization of the inversive congruential generator of pseudorandom numbers with prime-power modules is considered and the exponential sums on sequence of pseudorandom numbers are estimated. Also we obtained the estimate of the average value of exponential sums over initial value y□. The estimates for discrepancy of s-dimensional "overlapping" points are obtained.
Keyword: inversive congruential pseudorandom numbers, exponential sum, discrepancy

On the wave velocity of N-vortex ensembles in ring formation

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This article focuses on the speed of N-equal strength vortex ensembles arranged symmetrically around a circular ring. Using image processing we have

detected waves (vortices) within waves (vortices); along with the dominant waveforms there are also waves of the other states. We find that Kelvin's simple analytical relationship for of the ensemble speed being proportional to (N-1)/N to hold true not only within the equilibrium states but also inside the transition (mixed-state) gap. Previously we were unable to visualize the N = 7 vortex cluster. Sequential images of a short-lived heptagon have also been finally captured. The last is unable to stabilize and appears as if it is in a continuous state of transition.

Keywords: Kelvin's equilibria, vortex dynamics, stability of vortices

Study of complex dynamics in an pH-oscillatory chemical reaction

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The reaction system hydrogen peroxide-thiosulphate-sulfite in acidic solution belongs to the extensive family of pH-oscillators because under certain conditions it provides significant pH variations in time implying autocatalytic nature of hydrogen ions. This system is known to display nonlinear behaviour in a continuous-flow stirred tank reactor. Dynamical regimes occurring in this system depend on external constrains such as temperature, flow rate or inlet concentrations of reactants. The hydrogen peroxide-thiosulphate-sulfite system displays interesting dynamics as the flow rate k_0 is varied. The observed dynamical regimes of this reaction are periodic, aperiodic oscillations, chaotic behaviour and various stable steady states coexist over a range of operating conditions. Presented work is focused on experimental study of aperiodic dynamics of the system and subsequent time series analysis. The analysis is based on the reconstruction of the attractor from the measured time series using two different methods.

Keywords: Chemical reactor, aperiodic oscillations, time series analysis

Extension of Poincaré's program for integrability and chaos in Hamiltonian systems

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In the last chapter of Poincaré's famous three vols. on celestial mechanics, he outlines a program to establish chaos in dynamical systems by identifying periodic and in particular homoclinic and heteroclinic solutions. The geometric insight and the analytic skill to carry out the program has been a severe restriction until now. On the other hand, useful extensions were produced by applying Shilnikov's bifurcation (Devaney) and normal form methods for

Hamiltonian systems. The second method was initiated by Poincaré but can be extended to obtain measures of chaos in a number of cases. We will discuss applications in two- and three- d.o.f. systems, chains of oscillators and PDEs where (hidden) symmetries often play a part.

Robotics systems group control synthesis: synergetics approach

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We propose new systemic approach to robotics systems operation control by using multidimensional and multilinked nonlinear mathematical models of motion as well as nature of its interdependence and mutual influence. The base of proposed approach is a synergetics principles of multilinked dynamics system hierarchy: complex robotics systems are presented as some hierarchical macro-systems; system's dynamics at each level of hierarchy is described by dynamics of subsystems with variables and parameters immanent to specific level of model abstraction. On each hierarchical level the macro-system has own invariant, i.e. local aims. Then the designing system will have a hierarchical structure in a whole determined by a totality of interrelated natural and artificially introduced invariants. So, the proposed approach to robot groups control system design provides development of a new class of hierarchical control systems for complex robotics system operated in conditions of indeterminacy.

This work was supported by the Russian Foundation for Basic Research (grant no. 10-08-00912-a)

Applications of chaotic laser correlation ranging technology

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We demonstrate the applications of the chaotic laser correlation ranging technology in free space and transmission lines. In free space, a chaotic lidar system using chaotic laser as probe light source is designed and presented. We expand the application of the ranging technology to the fiber fault location, and a chaos correlation optical time domain reflectometer is proposed and demonstrated. Also, the chaotic laser can be converted to the electric chaotic wideband signal which is used to locate the cable fault.
Keywords: chaotic laser, chaotic lidar, optical time domain reflectometer, wire fault location, laser diode

Ultrahigh-bandwidth chaos generation using fiber ring resonator seeded with chaotic light

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We demonstrate experimentally a fiber ring resonator with an inbuilt optical amplifier to generate wideband chaotic signal. Seeded by a 6.5GHz chaotic light from an optical feedback laser diode, the fiber ring resonator emitted a chaotic signal with an ultrahigh bandwidth exceeding 26.5GHz.
Keywords: chaos, bandwidth, fiber ring resonator, semiconductor lasers

Nonlinear Detrending In Panel Models To Estimate Macroeconomic Effects On Mortality

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Previous investigations of the effect of macroeconomic conditions on mortality have often used fixed-effect panel models applied to mortality rates and unemployment rates in levels (or log-transformed). We show in the present investigation that this type of panel models often generates special patterns of the residuals and therefore violation of the regression model assumptions, that probably bias the effect estimates. Using panel regression models applied to differenced or Hodrick-Prescott-detrended data the high serial correlation of the observations is thoroughly removed and the patterns of the residuals disappear.

Nonlinear Effects of Actuator Induced Turbulence in a Controlled Flow System

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We develop and apply a technology for the automatic detection and real-time mitigation of accidental or deliberate hazardous releases in infrastructure systems. The automatic sensing and containment of a chemical release in these facilities are vital because of the catastrophic potential to human life. The proposed technology can be used to protect a passenger terminal,

transportation tunnel, tall building or conduit carrying water to a municipality in a reliable, cost-effective and socially acceptable way.

A prototype is used at laboratory scale to demonstrate the detectability and controllability of hazardous releases in real time. Microsensor arrays capable of detecting a broad menu of chemical agents are installed at strategic locations in the prototype. The sensors detect the instantaneous, spatially distributed concentration of the chemical agent and transmit the associated information to a predictive control model run by real-time hardware. The model provides optimal operation scenarios for computer controlled bleed valves mounted on the channel walls and connected to a common manifold. Mitigation and final elimination of the chemical cloud is achieved by optimal blowing and suction of ambient fluid or injection of counteracting chemicals.

The predictive control model is based on the dynamics of ambient fluid flow and fate and transport of the hazardous release. Gradient information is obtained by use of adjoint equations, so optimization of the control actions is achieved with high efficiency. The control is optimized over a finite prediction horizon and instructions are sent to the valve manifold. Next, the sensor arrays detect all changes effected by the control and report them to the control model, which advances the process over the next finite horizon. Sensing, optimization and feedback is achieved in a time period shorter than the prediction horizon, so the process can proceed in real time.

The purpose of the present paper is to present some unexpected nonlinear flow patterns that are generated by blowing and suction of fluid through the bleed valves. The optimization process is typically constrained by the valve flow capacity, which in many cases may be too high for a given flow system. Turbulent eddies generated by the actuators have a significant impact on the flow and spreading of the chemical agent, thus altering the control action in a nonlinear fashion that is impossible to predict. The result is a growing control instability, as the unanticipated turbulent eddies call for additional control action that results in even greater turbulent eddies. Matters are further complicated in applications to free surface flows, in which the blowing and suction result in surface waves. Reflection and refraction of these waves not only complicates the flow patterns beyond what is possible for the control model to predict, but in certain cases lowers the free surface below the valve level. Blowing and suction becomes impossible, as air enters the bleed valve manifold, and the control system fails.

In this paper, we present some computational and laboratory experiments that demonstrate the potential for nonlinear flow patterns induced by boundary blowing and suction. Although the associated turbulent eddies are complicated and difficult to predict, we show that imposing additional constraints on the actuator motion reduces the turbulence intensity and minimizes the potential for nonlinear instability of the control. Our tests indicate that suction is much easier than blowing to control, especially as the blowing velocity increases. In the case of multi-valve blowing, the pattern of turbulent eddies becomes so complicated that often leads to control failure.

Stability of the Generalized Lorenz System

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We consider the stability of a generalized Lorenz system proposed by Macek and Strumik [1]. This four-dimensional model has an additional variable describing the profile of the magnetic field induced in a convected magnetized fluid.
In the present study we analyse this system depending on selected control parameters, by using analytic and Hurwitz-Routh methods. In particular, we examine various ranges of the control parameters for which various dimensions of unstable manifolds can be obtained. We have identified the Hopf bifurcation in which the dimension of the unstable manifold is increased or reduced [2]. Finally, we analyse the structure of the attractors of the generalized Lorenz system for the values of the control parameters at which different dimensions of unstable manifolds exists.
This allows a better characterization of stability of these attractors in the various regimes.
Keywords: Nonlinear systems, hydromagnetic convection, stability, chaotic dynamics.

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Collision Frequency leads the Plasma in a Chaotic State. Influence on the Conductivity

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In some cases, plasma turbulence exhibits the signature of vortex structures. In this paper, the very important role of stereo-electrostatic waves in those nonlinear behaviors is attempted to be studied. Using the two-fluid model, a set of nonlinear equations is obtained, which are capable of describing the dynamics of long wavelength drift instabilities, as well as of giving a reason for the plasma turbulence rising. It is shown that collision frequency seriously affects the plasma stability, and interferes with all wavy phenomena. The presupposed conditions and the expressions for the growth rates are given as well.

Furthermore, it is found that possible stationary solutions of the nonlinear equations can represent the vortex structures.
Keywords: plasma stability, plasma instabilities, turbulence, chaotic state, vortex structure, feed-back state, chaotic simulation.

Chaotic Aeration For A Membrane Reactor

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Bubble column reactors are widely used in water treatment systems such as bio-granulation and hollow fiber membrane units. Many studies on their applications (e.g. [1]; [2]; [3]; [4]) have been reported in the literature. The hydrodynamics of bubble column reactors is complex due to the two phase interactions between the air and water medium [5]. The hydrodynamics include the formation of time-average circulation cells within the column, as well as turbulence fluctuations at different locations. Despite the complexity, it is critical to be able to quantify the hydrodynamic characteristics due to their importance in influencing the processes inside the reactor. For example, in the wastewater membrane bioreactor a membrane module is submerged in the bioreactor containing a suspension of biofloc (mixed liquor). The membranes provide a filtered product, removed by suction. However membrane performance can be reduced by fouling. Importantly, the control of fouling depends significantly on the bubble-induced hydrodynamics around the membrane surfaces [6].
In previous studies, the hydrodynamics in the bubble column have been analysed mostly by the analysis of the mean flow velocity and the turbulence intensity at different locations in the reactor. However, increasingly it is now recognised that turbulence behaviour is chaotic [7], and the chaotic hydrodynamic characteristics, such as fractal dimension, strange attractor, Lypanov exponent, may also play a role in influencing the outcome and efficiency of the units. The objective of the present experimental study is to investigate the effect of chaotic aeration by a bottom air stone inside a bubble column reactor on the filtration performance of a submerged membrane module. Several series of experiments are conducted:

1. In the first experimental series, the bubble column was filled with clean tap water up to 1 meter depth. A constant air flow rate of 2.2l/min was then released though the air stone. Subsequently, a pressure sensor was submerged to obtain the pressure time series at four locations (0.25m, 0.40m, 0.55m and 0.70m above the bottom of reactor). Based on the time series, the fractal dimension, strange reactor and Lynapov exponent were established.

2. In the second experimental series, the operating conditions were identical to the first series, except a point membrane module rather than a pressure sensor was submerged in the reactor at the four locations. A

constant flux of 47.75l/m^2·hr was then extracted by the membrane module, and the trans-membrane pressure (TMP) was monitored for 2 hours. The TMP history, shown in Figure 1, shows that the membrane performance was similar at the four locations. This is expected because the same membrane module was used in all 4 tests, and thus the TMP value thus represented essentially the resistance pressure over the membrane.

3. In the third experimental series, a 2.5 g/l Bentonite solution (simulating a mixed liquor suspension) was added to the reactor. Experiments with constant fluxes and aeration rates identical to Series 2 were then conducted, and the TMP was recorded in a similar manner. Figure 2 shows the time history of the TMP measurements. It was obvious that fouling of the membrane module occurred at all 4 locations, leading to a slow increase in TMP over time. The performance was however better at 0.25 and 0.4m compared to 0.55 and 0.7m.

The above three experimental series were repeated for different air flow rates. In the full paper, we shall discuss the quantitative relationships between chaotic hydrodynamic parameters and membrane performance observed.

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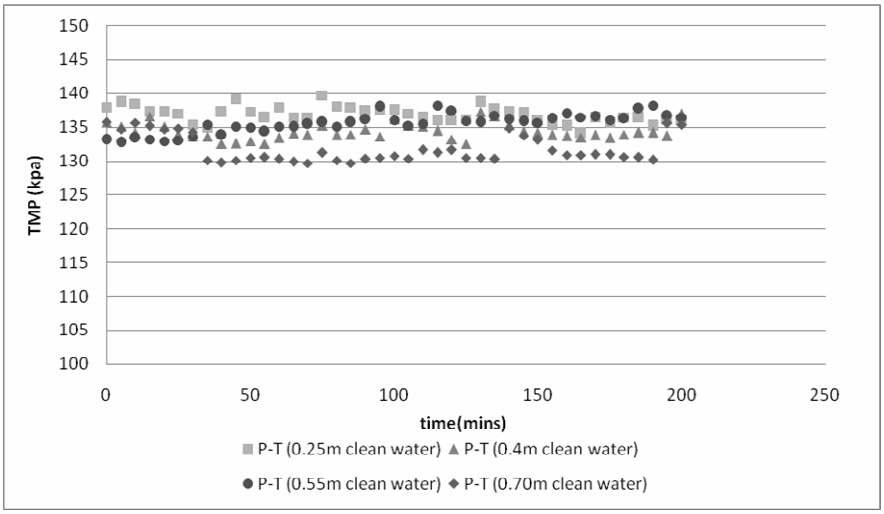

Figure 1 Time history of TMP at four locations in clean tap water

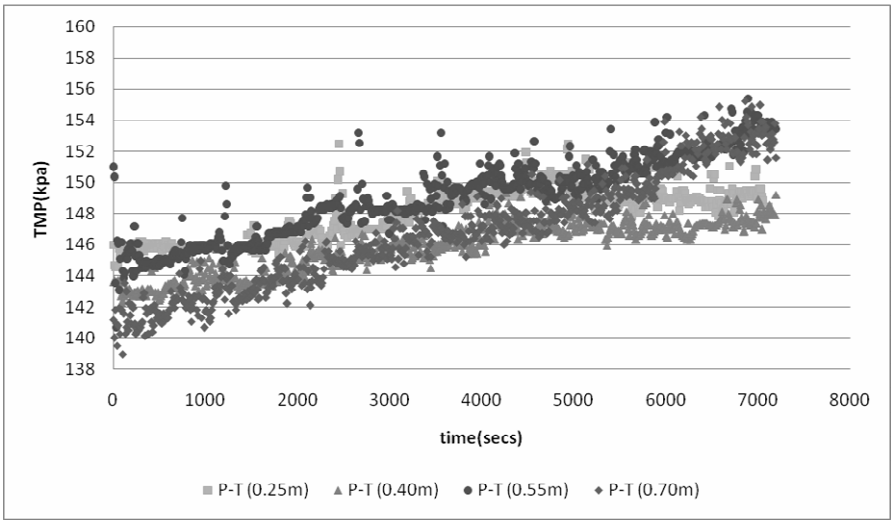

Figure 2 time history of the TMP at four different locations in bentonite solution

Information Complexity Regime in the Stock Market Noise Traders Population Growth Model

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The goal of this paper is to create theoretical underpinning for the growing evidence of patterns before market crashes and to encourage development of dynamic models detecting emergence of self-organizing behavior. Increased information complexity leads to herding and rule based trading, where traders influence each others' decision. Log-periodic oscillations of index levels before crashes have been proved empirically, as well as the occurrence of bi-modal demand function above threshold noise level. I apply the logistic equation to model the arrival of buy orders and their rate of growth. As buy orders are 'irrational' in a bubble regime, they are proposed to be a result of herding and imitation. Traders' network topology changes from random to scale free and synchronization of trading leads to a crash. Random networks synchronize differently than scale free networks. The goal is to confirm the increasing coupling and loss of heterogeneity leading to a new attractor "the critical point" and crash. Non-linear dynamical representation points at effective intervention strategies to build resilience and prevent crashes.
Keywords: Chaotic modeling, Stock-market bubble-build up, Imitation and herding of traders, Costly information

pH Oscillations in the Bromate-Sulfite-Perchloric Acid Reaction

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The dynamics of oscillations in chemical reactions has stimulated a wide research interest and produced thousands of studies on about 70 known chemical oscillators, notably over the past 50 years. Oscillating chemical reactions find many applications in Physics, Biology, Geology, Physiology and Medicine.

The dynamics of the bromate-sulfite-perchloric acid (BSH) reaction is investigated in a continuous-flow stirred tank reactor (CSTR), with Mn^{2+} as a proton-consuming (or negative feedback) species. This reaction is known to exhibit periodic oscillations in $[H^+]$, and it thus belongs to a sub-category of chemical oscillators, called pH oscillators.

The reaction is carried out at 45□C, and a flow rate of 1.59 mL/min. The oscillations are monitored in the $[Mn^{2+}]$-$[BrO_3]$ phase space, wherein a bifurcation diagram is constructed to delineate the regions of the various behavior regimes. Under our prevailing conditions, a shorter period and higher amplitude of oscillation than those reported in the Literature were obtained. A decrease in the period of oscillations from 40 minutes to 10 minutes in our system under newly imposed $[BrO_3]_0$ conditions renders the system more feasible and practical for study. A variation in the flow rate and residence time was also conducted.

Decreasing the flow rate from 1.59 mL/min to 1.35 mL/min caused a doubling of the period of oscillations. But over the entire spanned range, no chaotic behavior was observed.
Keywords: Chaotic modeling, The stock-market problem, Stock-Market, Innovation diffusion modeling, Lotka-Volterra, Simulation, Chaotic simulation.

Methods of tribosystem synergetics control

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We analyze the mathematical model of the evolution system as a set of non-linear differential equations, the parameters of which are presented as the integral operators of Volterra of the second type. Such system has a potential of the evolution changeability, dynamic restructuration and characterizes the changes of its features including bifurcations in the process of the natural functioning.
In the report we present the calculation algorithms for evolution trajectories as well as the methods of identification of the nucleus of the integral operators. We provide the practical example and results of mathematical modelling and computer simulation.

Bifurcation Theory Of Nonlinear Dynamics And Chaos Based On New Topological Concepts

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The main topological features and components of a new so-called *bifurcation theory of nonlinear dynamics and chaos* and its applications, intended for direct global bifurcation analysis of nonlinear dynamical periodic systems is presented. The described part of bifurcation theory uses dynamical periodic systems, described by a model of ODE equations or a map-based model of discrete-time equations. Our approach is based on ideas of Poincaré, Andronov and other scientists' results concerning structural stability and bifurcations of different dynamical nonlinear systems and their topological properties. For illustration of the advantages of the new bifurcation theory we use in this paper several typical well-known nonlinear models: Duffing driven oscillator, trilinear soft impact driven model and pendulum driven oscillator. In each of them we have found important unknown regular or chaotic attractors and/or new bifurcation groups with rare attractors RA. Additional illustration of the bifurcation theory it is possible to find in the author's and his colleagues papers.

Dynamics of exploited partially open trophic chains of a resource-consumer type with possible omnivory effect

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Dynamic models of trophic chains described by ordinary differential equations demonstrate both regular – equilibria and periodic orbits - and irregular structures under variation of their parameters. In fact, there are two methods for modelling food chain dynamics: the most popular approach is based on equations of interacting populations connected by predator-prey relations where the first species is usually self-regulated, while another - less widespread techniques - considers a chain in units of the entering resource with its explicit description [1]. For the second approach, a collection of interesting dynamic features on bifurcations of equilibria under the nutrient inflow increase and strange attractor formation was established earlier [2, 3]. Extension of this approach with several resource inputs and omnivory effect is initiated by aquatic food chains, which in most cases use detrital reservoir as an additional energy source for growth and maintenance. The main purpose of this work is to study and compare nonlinear dynamics of spatially uniform closed and partially open trophic chains of that type with and without omnivory at the first two levels. Omnivory effect results in appearance of steady states with intermediate zeros among coordinates while for trophic chains without it only equilibria with zeros in k (k = 0,…n-1) last levels may exist. Conditions of stability loss for co-dimension one and two bifurcations for boundary and non-trivial steady states for the two-level chain model with explicit resource are derived. They form the bifurcation diagram in the parameter space of the input resource intensity and harvesting mortality coefficient for the top trophic level. If the omnivory coefficient is small or zero, rising a harvesting mortality coefficient can result in a rapid decreasing of the last species in the chain to zero, and the chain itself to be shortened. In the parametric portrait stability domains of those steady states and periodic solutions are distinguished using a bifurcation analysis. Under the growing input resource pressure, the chain model with Holling types II and III trophic responses demonstrates a strange attractor formation by a period doubling bifurcation scenario both with omnivory and without it. Irregular stochastic invariant sets were not revealed in trophic models with Volterra functional responses. Examples include exploited partially closed trophic chains of Okhotsk and Bering Seas at the Russian Far East with omnivory effect in one of them symbolyzing the microbial loop providing higher trophic levels with additional energy.

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Attractor dimension at the synchronization transition of delayed chaotic systems

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A network of nonlinear units interacting by time-delayed couplings can synchronize to a common chaotic trajectory. Although the transmission time may be very long the units are completely synchronized without time shift.
We investigate the attractor dimension at this transition to complete chaos synchronization. In particular, for networks of iterated maps we determine the Kaplan-Yorke dimension from the spectrum of Lyapunov exponents which is calculated analytically for Bernoulli maps and numerically for Tent maps. However, we argue that the Kaplan-Yorke conjecture cannot be true at the transition. For the synchronized state the Lyapunov exponents perpendicular to the synchronization manifold cannot contribute to the attractor dimension. Consequently, the Kaplan-Yorke dimension has to be discontinuous at the transition. We calculate the magnitude of this jump for different networks.
The Kaplan-Yorke dimension is an upper bound for the correlation dimension. Using the method of Grassberger & Procaccia we calculate the correlation dimension for networks of iterated Bernoulli and Tent maps. For Bernoulli networks the correlation dimension jumps at the transition to synchronization whereas for Tent maps the correlations dimension is continuous. We conclude that for some systems the Kaplan-Yorke conjecture yields qualitatively incorrect results.
Keywords: Chaos and Nonlinear Dynamics, Chaos synchronization, attractor dimension

Discriminant analysis applied to the disruption prediction on Tokamak

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The controlled fusion can provide a sun-like energy source based on a self-sustained and eco-friendly principle, which is considered to be one of important approaches to overcome the energy exhaustion and environment problem in the future。Tokamak is a kind of presently popular device dedicated on the magnetic controlled fusion. Disruptions are major concerns in the operation of tokamaks. Discriminant analysis is a statistical method of multivariate analysis based on the Bayes' theorem, which has been extensively applied to the investigation of experiment data on tokamaks. In this paper, discriminant analysis is performed on the disruptive data on ASDEX Upgrade tokamak, and is used to derive a mathematic model to be able to forecast in real time the occurrence of a disruption during a discharge. The mathematic model can be a linear or quadratic discriminant function according to different covariance structures adopted in the data analysis. Variable significant is

identified, and the best combination of variables is searched out before the discriminant function is build.
Keywords: Discriminant analysis, classification, disruption prediction.

Hierarchical socio-economic model of the ecosystem "Silicon Valley"

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Creation of Russian Silicon Valley in Skolkovo (near Moscow) is a challenging and ambitious project. It is therefore important to assess how realistic this problem is and what impact on socio-economic life in Russia it can produce.
In our report we present some approaches for constructing mathematical model of Skolkovo-cluster development, treating it as the "ecosystem". Special attention is paid to the problem of transforming qualitative characteristics to numerical values. Some preliminary results of numerical simulation are presented. We also discuss socio-economical impact of Skolkovo-cluster development.

Simulation of quantum graphs by microwave networks

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We show that chaotic quantum graphs of connected one-dimensional wires can be experimentally simulated by irregular microwave networks consisting of coaxial cables. The spectra of the microwave networks are measured for bidirectional and directional networks. The directional networks consisting of coaxial cables and microwave circulators simulate quantum graphs with broken time reversal symmetry. In this way the statistical properties of the graphs such as the nearest neighbor spacing distribution and the spectral rigidity are obtained. We also demonstrate that microwave networks with absorption can be used to investigate properties of open quantum systems which recently have been extensively studied in the context of transparent electronics and new biosensors. We report the first experimental studies of the distributions of Wigner's reaction K matrix and the enhancement factor for the networks simulating open quantum graphs with broken time reversal symmetry. We demonstrate that the experimental results are in good agreement with the random matrix theory predictions. Furthermore, we present the results of studies of the parametric level correlations and the fidelity decay in the graphs.

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Nonlinear Analysis of Shipping Problem

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This work analyzes the ship chartering problem using a nonlinear system approach. Simulations of the resulting system are presented and the analogy with known nonlinear systems is discussed.

Nonlinear Forecasting of European Business Cycle Indicators

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The European Business Cycle data collected by European Commission are used to evaluate the economic situation of European Union. In this paper those time series data analyzed by nonlinear methods and their ability to forecast is examined.

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