Contributed Sessions

On Some Stochastic Parabolic Differential Equations in a Hilbert Space (2002)

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In this paper, we consider the stochastic difference partial differential equations of the form

$$\begin{aligned} du(x,t,c) &= L(x,t,D)u(x,t,c)dt + \\ &+ \sum_{i=1}^{n}\sum_{j=1}^{k}[b_{ij}(x,t)\frac{\partial}{\partial x_i} \\ &+ b_{0j}(x,t)]u(x,t-c_j,c)dw_{ij}(t), \end{aligned}$$

$x = (x_1, ..., x_n) \in S,\ t > 0,\ c = c_1, ..., c_k),\ 0 < c_j < T_0,$
$j = 1, ..., k.$

We assume the initial and boundary conditions,

$$u(x,0,c) = u_0(x),\ x \in S$$

$$u(x,t,c)|_{\partial s} = 0,\ t > 0,$$

where S is a bounded set of the n-dimensional Euclidean space, ∂S is the smooth boundary of S, u_0 is a given suitable function and w_{ij} are mutually independent Wiener porocesses,

$$i = 1, ..., n;\ j = 1, ..., k.$$

It is supposed that $L(x,t,D)$ is a linear uniformly elliptic partial differential operator of the second order.

The existence and uniqueness of the solution of the considered stochastic mixed problems are studied. Some properties are also studied.

A more general stochastic problem is considered in Hilbert space and then the results concerning stochastic difference partial differential equations are obtained as applications.

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Persistence and Extinction for General Nonautonomous n-Species Lotka- Volterra Cooperative Systems with Delays (2445)

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We consider the following general nonautonomous n-species Lotka-Volterra cooperative system with delays

$$\begin{aligned} \frac{dx_i(t)}{dt} &= x_i(t)[b_i(t) - a_{ii}(t)x_i(t) \\ &- \sum_{j\neq i}^{n} a_{ij}(t)x_j(t-\tau_{ij}(t)) \\ &- \sum_{j\neq i}^{n}\int_{-\sigma_{ij}}^{0} c_{ij}(t,s)x_j(t+s)ds], \\ i &= 1, 2, \cdots, n. \end{aligned}$$

Where $t \in R_+ = [0,\infty)$, $x_i(t)$ represents density of i-th species at time t and $x(t) = (x_1(t), x_2(t), \cdots, x_n(t)) \in R_+^n = \{(x_1, x_2, \cdots, x_n) : x_i \geq 0, i = 1, 2, \cdots, n\}$, $b_i(t)$ represents the intrinsic growth rate of the i-th species at time t.

By using the method of Liapunov functions, we established a series of new criteria on the uniform strong persistence, uniform weak average persistence, uniform strong average persistence of some of the species and the extinction of the surplus species for this system.

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A Maximum Principle for Higher Order Ordinary Differential Inequalities (2020)

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In this paper we introduce a maximum principle for higher orde ordinary differential inequalities.

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Oscillation of Nonlinear Impulsive Parabolic Equations with Several Delays (2435)

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In this paper, oscillatory properties of solutions for certain nonlinear impulsive parabolic equations of neutral type with several delays are investigated and a series of new sufficient conditions and a necessary and sufficient condition for oscillation of the solutions are established. The equation here we discuss is nonlinear and the boundary condition is also nonlinear. Some published results are special case of our results. The results fully indicate that the oscillation are caused by delays,impulse. And hence reveal the varied difference between these equations and those without delay and impulse.

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Stability of Recede Motions in Dynamical Systems (2324)

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It is known that the motions in dynamical systems may be classified according to their relations with the associated alpha and omega limit sets into the following classes: recede motions, asymptotic motions, and Poisson stable motions. This paper is devoted to the stability of recede motions. Necessary and sufficient conditions are proved of stability of invariant sets of recede motions for dynamical systems in metric spaces. The Liapunov stability and orbital stability of recede motions for periodic dynamical systems are also investigated.

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On the Set of Solutions of Quantum Stochastic Differential Inclusions (2613)

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Under the framework of the Hudson - Parthasarathy formulation of quantum stochastic calculus, we prove that a multifunction associated with the multivalued solution map of a Lipschitzian quantum stochastic differential inclusion admits a selection continuous from the field of complex numbers to the space of the matrix elements of the set of adapted, weakly absolutely continuous stochastic processes.

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A Generalized Harmonic Oscillator Having Angular Frequency Depending Quadratically on the Velocity* (2289)

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Ronald E. Mickens

We investigate the possible solution behaviors of a nonlinear, one-dimensional oscillator where the square of the angular frequency is an even quadratic function of the first-derivative. Our interest in this equation arises from the observation that the application of the method of harmonic balance gives an approximation to the solution for which the angular frequency is singular at an amplitude value of two [1]. Our study of this equation shows that such singular behavior does not in fact occur. We demonstrate that all solutions are periodic for arbitrary initial conditions. The basic technique used to obtain this result is to examine the system form of the second-order differential equation in the two-dimensional phase plane. We also calculate a perturbation solution using the L-P method [2] and use the obtained result for the periodic solutions to help us understand why an apparent singularity seems to exist in the amplitude dependence of the angular frequency for the harmonic balance method.

*The work reported here is supported by the Title III Program at Clark Atlanta University.

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2.R. E. Mickens, Nonlinear Oscillations (Cambridge University Press, New York, 1981).

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On Three Nonlinear Systems: Dynamic Neural, Fuzzy and Wavelet Networks For Training Trajectories (2167)

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Intelligent system covers a wide range of technologies related to hard-sciences such as the modeling

and control theory and soft-sciences such the artificial intelligence (AI). Intelligent systems are modeled after biological systems and human cognitive capabilities. In this aspect, the use of neural networks, fuzzy logic and wavelet techniques in modeling areas are presented. Neural networks (NNs), fuzzy logic (FL) and wavelet systems have been recognized as a robust and attractive alternative to the some classical modeling and control methods. The application of classical NNs, FL and wavelet technology to dynamic system model and control has been constrained by the non-dynamic nature of popular architectures of those. Many of difficulties are too many parameters, large rule bases and too many wavelets (i.e. curse of dimensionality), long training times, etc. These problems can be overcome with dynamic network structure of NNs, FL and wavelet (which are called dynamic neural network-DNN, dynamic fuzzy network-DFN and dynamic wavelet network-DWN), a network with unconstrained connectivity and dynamic neural, fuzzy and wavelet processing units called "neuron, feuron, and wavelon" respectively. In this study, it has been studied as comparison with DNN, DFN and DWN a nonlinear dynamical system modeling. All these three dynamic networks have a lag dynamic, as activation functions (general sigmoid in DNN, fuzzy membership functions in DFN and non orthogonal mother wavelets in DWN) and interconnection weights. Network weighs are adjusted based on supervised training. With fast training (optimization) algorithms (quasi-Newton methods), all networks are trained. Generally, wavelet is widely used in processing of signals and data. It has been also shown that all dynamic networks can be effectively used in nonlinear system modeling. And also shown that DWN has the best capacity, the later is DFN and the last is DNN. But, all networks have nonlinearity properties in nonlinear systems. Dynamic network structure is based on Hoppfield networks In this study, all dynamic networks is considered as a nonlinear optimization with dynamic equality constraints for nonlinear system modeling. For this, they encapsulate and generalize the target trajectories. The adjoint theory (whose computational complexity is significantly less than direct method) has been used in the training of them which are as a quasi-linear dynamic system. The updating of weights (identification of network parameters) are based on Broyden-Fletcher-Goldfarb-Shanno (BFGS) method. First, phase-portraits based examples are given. For this, it has been shown that they have oscillator and chaos properties. The last, a dynamical system with discrete-event is modeled using them. There is a localization property at discrete-event instant for time-frequency in this example.

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Asymptotic Behaviour of Solutions of Linear Difference Systems with Delays (2064)

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Let t_0 be a fixed integer and $[t_0, \infty)$ denote the semi-infinite discrete interval in $\mathbf{Z}$. We deal with the nonhomogeneous linear delay difference systems

(1)
$$\Delta x(t) = A(t)[x(t-\sigma)-x(t-\tau)]+f(t) \quad \text{for} \quad t \in [t_0, \infty),$$

where Δ denotes the forward difference operator defined by

$$\Delta x(t) = x(t+1) - x(t),$$

and $A : [t_0, \infty) \to \mathbf{R}^{n\times n}$ is a matrix function, $f : [t_0, \infty) \to \mathbf{R}^n$ is a vector function, $0 \leq \sigma < \tau$ are some fixed integers (delays).

The initial condition associated with (1) has the form

$$x(t) = \varphi(t) \quad \text{for} \quad t \in [t_0 - \tau, t_0],$$

where $\varphi : [t_0 - \tau, t_0] \to \mathbf{R}^n$ is a given vector function.

Sufficient conditions are given for the asymptotic constancy of the solutions of system (1). Moreover, it is shown that the limits of the solutions, as $t \to \infty$, can be computed in terms of the initial function and a special matrix solution of the corresponding adjoint equation.

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Bifurcations of Automodel Solutions of the Fokker-Plank Equation. Applications to the Modelling of Genome Dynamical Evolution (2538)

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The power and Pareto distributions $P(i) = c(i + a)^b$ (a,b,c are constants) appear in an astonishing variety of fundamentally different contexts. We proved earlier that the stationary solution $f(i)$of the birth-and-death model follows the Pareto distribution if, and only if, birth and death rates are asymptotically (by i) equal up to the second order. Here we study the diffusion approximation of that birth-and death models and prove that the Pareto distribution emerges as

the stationary solution of the FPE corresponding to a special class of diffusion processes with the dispersion $s^2 = x^d(1+o(1))$and the drift $m=x^{d-1}(1+o(1))$. We found also a family of automodel solutions of the form $f(x,t)=(x+a)^b G(x/t^e)$ with $e=1/(2-d)$ if 1¡d¡2 and $f(x,t)=(x+a)^b G(xexp(kt))$ if $d=2$ (here e,k are constants). These solutions describe the process of transformation of the "initial" stationary solution to the "final" one.

We applied the developed formalism to the analysis of the size distributions of domains in individual prokaryotic and eukaryotic genomes.

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Extented Riemann Bessel Functions (2103)

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In this presentation we discuss the Extended Riemann Bessel functions, their integral representations and series expansions in terms of Riemann zeta function and in terms of Bessel function.We consider also other properties such as the differential equations satisfied by these functions, their recurrence relations and a recent proof of the Hurwitz type formula. Applications to wave propagation is also explored.

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Existence of a Weak Solution for a Fluid-Structure Interaction Problem (2316)

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In this lecture, we will study the three dimensional motion of an elastic body immersed in an incompressible viscous fluid. The body and the fluid are contained in a fixed bounded set. On the elastic structure, we have a rigid motion combined with small elastic deformations. The equations of rotation motion and of the elastic deformations are coupled. The existence of a weak solution to this problem is shown as long as elastic deformations are not too important and no collisions between the structure and the boundary of the global domain occur.

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Nonlinear Differential Equations via Denjoy-Perron Type Integrals (2072)

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In this talk we will be dealing with initial value problems involving the theory of nonabsolute convergent integrals (i. e. the Denjoy-Perron type integral). We discuss upper and lower solutions for these problems and we give a variety of existence theorems for solutions which are bounded by a priori given functions satisfying some necessary conditions. Further, we discuss maximal intervals where a solution might exist. Finally, we discuss the topological structure of global solution sets. It appears that under suitable assumptions such a set is a R_δ set that is it is homeomorphic to the intersection of the decreasing sequence of compact absolute retracts.

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Almost Automorphic and Asymptotically Almost Automorphic Solutions to Differential and Integral Equations in Banach Spaces (2065)

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At the beginning of the talk we present Aronszajn type theorems for solutions of the Cauchy problem as well as the nonlinear Volterra integral equation, defined on the whole real line. Recall that a given problem has the Aronszajn property if a set of its solutions defined on a common interval is an R_δ, that is, it is homeomorphic to the intersection of a decreasing sequence of compact absolute retracts. In particular, it is a nonempty, compact and connected space which is acyclic with respect to the Čech homology functor.

Next, we will deal almost automorphic as well as asymptotically almost automorphic solutions to these problems in Banach spaces. We present a collection of existence results of such solutions to these equations.

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Bifurcation Study of Self-Oscillatory and Chaos Regimes in Three Dimensional Models of the Predator-Prey Systems (2003)

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For models of the dynamics of the quantity of a predator-prey systems such as the generalized Lotka-Volterra models with the additional effects of an intraspecific competitions and saturation we show existence of Self-Oscillatory and Chaos regimes behaviour and investigated them bifurcation at changes value of parameters and initial values of number of populations.

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About a Guess to a Critical Value for Global Nonexistence Theorem of a Wave Equation (2233)

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Consider the Cauchy problem for the nonlinear wave equation in 2-dimension space with sufficiently regular data which have compact support. Glassey.R given a guess to a critical value P(2): the global existence of the solutions holds if P > P(2); whereas global nonexistence may hold if P < P(2). But by our result a counter example is given to the guess of Glassey.R, which shows that the global nonexistence of the solution also holds even if P > P(2).

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Vortex Lattices in Nonlinear Media: a Molecular Dynamic Approach (2614)

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In this talk, inspired by the recent blossoming of experimental results on vortex lattices for Bose-Einstein condensates, we present a framework for studying such patterns and their structural transitions, using the Parrinello-Rahman (PR) variant of Molecular Dynamics (MD) simulations. Assuming an effective pairwise interaction between vortices derived from a Ginzburg-Landau field-theoretic context, we extract the ground state of a "vortex gas" using the PR-MD technique and find it to be a triangular pattern. Other patterns are also obtained for special initial conditions. Generalizations of the technique, such as the experimentally relevant inclusion of external potentials or excitation of quadrupolar modes, are also commented upon.

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Pitchfork Bifurcations of Invariant Manifolds (2026)

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We define a pitchfork bifurcation of an $(n-1)$-dimensional invariant submanifold of a dynamical system in $\mathbb{R}^n$, analogous to that in $\mathbb{R}$. We state sufficient conditions for such a bifurcation to occur and then prove the existence of the bifurcated manifolds under the stated hypotheses. Lastly the theorem is illustrated with some examples, including one from population dynamics.

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Wavelet-Galerkin Solution of Elliptic Boundary Value Problem (2590)

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In this paper we have made an attempt to show the advantage of Wavelet-Galerkin solution of elliptic boundary value problem in comparision to finite difference method. In computations, the sparsity and small condition numbers of the discrete operators are the key to efficiency. Sparsity enhances the speed of iterations, while the small condition number guarantees rapid convergence of such iterations. In general the matrices that we obtain using finite difference methods are sparse. However, they have large condition numbers. Using the Galerkin method with Fourier system, we can obtain a bounded condition number but the matrix is no longer sparse. In this paper we have made an attempt to show that in the Galerkin method with Daubechies wavelet base, we

obtain both the advantages.

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$$\longrightarrow \infty \diamond \infty \longleftarrow$$

Existence and Uniqueness of Almost Periodic Solutions (2018)

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We are concerned with the almost periodic solutions to the singular differential equations of type

$$(I - \zeta A)\frac{d}{dt}w(t) - Bw(t) = f(t), \quad (*)$$

where A, B are (unbounded) densely defined closed linear operators acting in a Hilbertspace $\mathbb{H}$, and $f : \Re \mapsto \mathbb{H}$ is almost periodic, and ζ is a nonzero constant. Under appropriate assumptions, it will be shown that bounded solution to $(*)$ is almost periodic solutions to $(*)$.

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On Piecewise Smooth Maps of a Circle (2067)

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In the present work we study piecewise smooth circle homeomorphisms i.e., maps that are smooth everywhere except several singularities where the first derivative is discontinuous. We consider the orientation- preserving homeomorphism $T_f x$ of the unit circle,

$$T_f(x) = \big\{f(x)\big\}, \quad x \in S^1 = [0,\ 1)$$

where the $\{\cdot\}$- denotes the fractional part of a number and $f(x)$ is a continuous strictly monotone function on R^1 with the following properties:

(a) $0 \leq f(0) < 1$;

(b) $f(x+1) = f(x) + 1$ for any $x \in R^1$;

(c) the homeomorphism T_f has the corners $x_{p_i} = T_f^{p_i} x_0, i = \overline{0,m}, \quad p_0 = 00$ for $f(x) \in S^1 \backslash \{x_{p_i}, i = \overline{0,m}\}$.

Condition (d) means that the function $f(x)$ belongs to the class C^2 on any connected component of the set $S^1 \setminus \{x_{p_i}, i = \overline{0,m}\}$.

Let the rotation number $\rho = \rho(f)$ is irrational. Denjoy showed that if $f(x) \in C^1(R^1)$ and $varlimits_{S^1} \log f'(x) < \infty$, then there exists a circle homeomorphism; T_φ such that $T_\varphi \circ T_f = T_\rho \circ T_\varphi$ where $T_\rho x = \{x+\rho\}$, is the linear rotation of the circle through an angle of ρ. An important problem in circle maps theory is to find relations between the smoothness of f , the properties of the rotation number ρ , and the smoothness class of the conjugation T_φ. This problem is closely related to the existense problem for an absolutely continuous (a.c.) invariant measure for T_f . Indeed, a unique probability invariant measure for T_f is a.c. w.r.t., the Lebesgue measure iff $\varphi(x)$ is an absolutely continuous function. This consideration was first used by Arnold $[A]$ to study smoothness of $\varphi(x)$. The strongest results in this field were obtained by Herman, Yoccoz, Katznelson and Ornstein, Sinai and Khanin.

In turns out that the situation becomes diametrically opposite in the presence of a single point x_c of break-type singularity. Namely, if $f(x) \in C^{2+\varepsilon}(S^1 \setminus x_c)$ for some $\varepsilon > 0$, then an invariant measure is always singular w.r.t. Lebesgue measure $[DK]$. Now we formulate our main results.

Theorem 1. Assume that a function $f(x)$ defining a homeomorphism T_f satisfies conditions $(a)-(d)$, $\prod_{i=0}^{m} c_i \neq 1$ and the rotarion number $\rho = \rho(f)$ is irrational. Then the invariant measure μ is singular w.r.t. the Lebesgue measure λ , i.e. there exists a measurable subset $A \subset S^1$ such that $\mu(A) = 1$ and $\lambda(A) = 0$.

Definition 1. Two measures ν_1 and ν_2 on the same σ- algebra are L^2-equivalent if $\nu_1 = \varphi_1(\nu_2)$ with $\varphi_1 \in L^2(\nu_1)$ and $\nu_2 = \varphi_2(\nu_1)$ with $\varphi_2 \in L^2(\nu_2)$.

Definition 2. Let ρ be irrational number and its continuous fraction expansion be $\rho = [k_1, k_2, ..., k_n, ...]$. If $k_n \leq$ const, $n \geq 1$, then we say that ρ is of bounded type.

Theorem 2. Suppose that a function $f(x)$ defining a homeomorphism T_f satisfies condititons $(a) - (d)$, $\prod_{i=0}^{m} c_i = 1$ and the rotation number $\rho = \rho(f)$ is irrational of bounded type. Then the invariant measure μ and the Lebesgue measure λ are L^2-equivalent.

Consider a homeomorphism T_f with an irrational rotation number ρ and satisfies the conditions of the

theorem 1. We construct a thermodynamic formalism for such homeomorphisms. It is used to study the behavior of Holder's exponents of singular invariant measure. Limit distributions of entrance times are also studied.

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Numerical Homogenization of Nonlinear Partial Differential Equations and its Applications (2141)

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The numerical homogenization methods presented in this talk are designed to compute homogenized solutions. In particular we are interested when the heterogeneities have random nature. I will describe numerical homogenization methods that we proposed recently and their relation to some other multiscale methods. Convergence of these methods for nonlinear parabolic equations will be discussed. Numerical examples and applications will be considered.

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On Some Fractional Differential Equations in the Hilbert Space (2001)

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Let A be a closed operator defined on a dense set in the Hilbert space H. fractional evolution equations of the form

$$\frac{d^{\alpha}u(t)}{dt^{\alpha}} = Au(t)$$

is studied in H, for a wide class of the operators, A, which in general have no resolvents, $(0 < \alpha \leq 1)$. The correct formulation of the Cauchy problem for the considered equation is studied under suitable conditions on the class of solutions. It is proved also that there exists a dense set S in H such that there exists a solution $u(t)$ of the Cauchy problem for the considered equation with the initial condition $u(0) \in S$. Applications to general partial differential equations of the form

$$\frac{\partial^{\alpha}u(x,t)}{\partial t^{\alpha}} = \sum_{|q|\leq m} a_q(x)D^q u(x,t)$$

are given without any restrictions on the characteristic form

$$\sum_{|q|=m} a_q(x)\xi^q \ , \text{ where } D^q = D_1^{q_1}...D_n^{q_n} \ , \ D_j = \frac{\partial}{\partial x_j},$$

$$\xi^q = \xi_1^{q_1}...\xi_n^{q_n} \ , \ |q| = q_1 + ... + q_n.$$

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Regular Approximation of the Variational Forms Associated with Singular Self-Adjoint Ordinary Differential Equations (2128)

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A method for approximating the variational forms associated with singular formally self- adjoint differential expressions of order $2N$ by regular ones is presented. The approximations are constructed in function spaces requiring only N classical derivatives. Convergence of the approximations is established.

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On Explicit Exact Solutions for the Linard Equation and its Application to the Complex Ginzburg-Landau Equation (2099)

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Feng [Phys.Lett. A 293 (2002)] obtained a kind of explicit exact solutions to the one form of the Liénard equation, and applied these results to find some explicit exact solitary wave solutions to some nonlinear partial differential equations. In this work, exact solutions of the complex Ginzburg-Landau equation with higher-order terms are obtained by seeking solutions of another more generalized Liénard equation.

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Dynamics of a Nonlinear Evolution Equation (2029)

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We study the evolution of the following equation in a bounded domain

$$u_{tt} + \Delta^2 u - \sum_{i=1}^{n} (\sigma_i(u_{x_i}))_{x_i} + g(u_t) = f(u) \quad \text{in} \quad \Omega,$$

with initial conditions

$$u(0) = u_0, \quad u_t(0) = v_0, \quad \text{in} \quad \Omega,$$

and with one set of boundary conditions

$$u = 0 \text{ and } \Delta u = 0 \text{ on } \partial\Omega,$$

$$\text{or} \quad u = 0 \text{ and } \frac{\partial u}{\partial \nu} = 0 \text{ on } \partial\Omega.$$

Here

$$f(s) = \mu s|s|^{r-2}, \mu > 0, r > 2,$$

$$g(s) = \delta s|s|^{\lambda-2}, \delta > 0, \lambda \geq 2,$$

and

$$|\sigma_i(s)| \leq \kappa(|s|^{m-1} + |s|), \quad 1 \leq i \leq n, \quad \kappa > 0, \quad m > 2,$$

e.g.

$$\sum_{i=1}^{n} (\sigma_i(u_{x_i}))_{x_i} = \pm\beta \sum_{i=1}^{n} u_{x_i,x_i} |u_{x_i}|^{m-2} + \alpha\Delta u,$$

$$\beta > 0, \quad m > 2, \quad \alpha > 0.$$

We present characterizations of blow-up and asymptotic behavior. We prove blow-up of solutions as well as convergence to the zero and nonzero equilibria and we give rates of decay to the zero equlibrum. In particular we prove instability of the ground state. We show existence of global solutions without a uniform bound in time for the equation with nonlinear damping. We define and use a potential well and positive invariant sets.

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A Mathematical Analysis of a Fish Size Spectrum (2367)

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This work is devoted to the study of a fish population size spectrum.In this research we improve a previous model that has been studied by O.Arino [1] The model is represented by a nonlinear partial differential equation with diffusion and transport Using an approximation approach,we prove that the problem is well posed and the solutions define a strongly continuous semigroup on some integrable functions.

References [1]O.Arino, Chr Mullon, Y shin and Ph Cury. Etude mathmatique d'un modle de croissance de la biomasse sous l'hypothse de prdation des moins gros par les plus gros. Preprint

$\longrightarrow \infty \diamond \infty \longleftarrow$

Dynamics in Diffusive Food Chain System with Time Delays (2655)

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We study, in this paper,a reaction-diffusion system modelling the dynamics of three-species food-chain interactions with time delay effects. The existence of global solutions and multiplicity of stead state solutions of the system are first established. A condition on the interaction rates is given to ensure persistence of all species in the food chain. It is also shown that the time delays are harmless for the permanence effect in this model. Numerical simulations of the food-chain models with or without time delays are also given to demonstrate and compare the dynamical behavior of the species.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Dynamics About an Asteroid Pair (2516)

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In August 1993, the Galileo probe came within 2,400 kilometers of 243 Ida, the second asteroid ever encountered by a spacecraft. The greatest discovery from this Galileo fly-by was that Ida has a natural satellite. This moon has been named Dactyl by the International Astronomical Union. Dactyl is the first natural satellite of an asteroid ever discovered and photographed.

Since then, over 50 binary asteroids have been discovered and interest in study asteroid pairs has grown significantly. Also, asteroid pairs can be seen as a

canonical example of more general Full-Body Problems, which may have important applications in other fields, for instance in molecular dynamics.

In this talk, we study a simple model of an asteroid pair. We consider the planar mechanical system made up of a rigid body and a sphere. Moreover, we assume that the potential of the rigid body can be approximated by the one of a dumbbell. This last assumption overcomes the intrinsic difficulties of the potential of a general rigid body and allows us to focus on the geometric and dynamical aspects of the problem. This model is also very interesting because, despite its simplicity, it already captures one of the main features of the problem, namely the coupling between rotational and translational motion.

The initial system is 3 degrees of freedom (dof) and is invariant under the action of the abelian Lie group $SO(2)$. Thus, using reduction theory, we can write the problem as a 2 dof Hamiltonian system. Afterwards, we modify the model by taking into account the effect of a third big and relatively distant object (Sun) as a periodic perturbation of the initial system.

By fixing the position of the spherical mass in a given solution of the system, we can construct a model for the motion of a spacecraft under the gravitational attraction of the asteroid pair and the Sun. Finally, we study the dynamics of this periodic time-dependent 3 dof system and explore how the "tube dynamics" can help in finding a path for the spacecraft that will lead it directly to the surface of the primary asteroid.

$$\longrightarrow \infty \diamond \infty \longleftarrow$$

Quantitative Recurrence, Complexity and Local Dimension (2583)

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It is well known that a typical orbit of a dynamical system will come back to any resonable neighborhood of its starting point if we wait for a sufficiently long time.

A question wich is naturally posed is "how much time I have to wait to come back near (in a given neighborhood) to the statring point?" This is what quantitative recurrence indicators describes. In the recent literature many relations have been proved between these indicators and many features of dynamics (entropy, Hausdorff and local dimension, orbit complexity, hyperbolic structures...).

We are interested to someting that is similar to quantitative recurrence indicators. These indicators generalizes the quantitative recurrence ones and they describes "how much time I have to wait to go from the point x to a neigborhood of *another* point y?". They are called *waiting time indicators*.

We discuss some relations between waiting time and local dimension. We want to show how these indicators can be used (togheter with quantitative recurrence indicators) to have an efficient numerical estimate of the local dimension.

Moreover, we will see how the relations between waiting time and local dimension can be used to calculate the orbit complexity of some interesting discontinuous low dimensional maps, such as the Interval Excange Transformations.

Here, the orbit complexity measures the quantity of information that is necessary to describe the behavior of an orbit. It is an indicator (invariant up to topological conjucacy) that tries to refine the entropy for the systems having zero entropy.

$$\longrightarrow \infty \diamond \infty \longleftarrow$$

Water-Gas Flows in Porous Media (2213)

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We consider the following model of water-gas flows,

$$\phi(x)\partial_t(\rho(p)s) - div(\mathbf{K}\rho(p)M_1(s)\nabla p)$$
$$-div(\mathbf{K}\rho(p)\alpha(s)\nabla s) + \rho(p)sf_p = 0, \quad (gas)$$
$$\phi(x)\partial_t s + div(\mathbf{K}M_2(s)\nabla p)$$
$$-div(\mathbf{K}\alpha(s)\nabla s) + sf_p = f_p - f_I. \quad (water)$$

The saturation s (function of time t and space x) corresponds to the incompressible flow (water) when $s = 0$ and corresponds to the compressible gas when $s = 1$. The intermediate value of saturation s corresponds to a mixing of water and gas. The variable p denotes the pressure of the gas and ρ its density. Other parameters and mixed Neuman-Dirichlet boundary conditions will be introduced and verify physical assumptions. The main difficulty in the system (gas) (water) is due to the degenerate term $\partial_t(\rho(p)s) = s\partial_t\rho(p) + \rho(p)\partial_t s$ when $s = 0$.

The goal of this talk is to introduce the existence of classical weak solutions to the system (gas) (water) under physical assumptions and for a non degenerate function α ($\alpha(s) \geq \alpha_0 > 0$). We will also introduce the existence of solutions in a weaker sense, when α

degenerates in $s = 0$ or $s = 1$. We also will recall some results we have obtained for degenerate α in a problem of compressible immiscible two-phase flows in porous media.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Nonlinear Hemivariational Inequalities with Eigenvalues near Zero (2010)

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We consider an eigenvalue problem for a quasilinear hemivariational inequality with null boundary condition and with subdifferential satisfying p-1-growth condition. We prove the existence of a nontrivial solution for eigenvalues sufficiently close to zero. The approach is variational and is based on the critical point theory for nonsmooth, locally Lipschitz functionals.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Optimal Control of a Commercial Credit Repayment Plan (2108)

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Eugene Khailov

In this paper, dynamics of a nonlinear controlled system of differential equations describing a firm that takes a loan in order to expand its production activities is studied. The objective of this work is to determine the optimal loan repayment schedule using the variables of a business's current profitability, the bank's interest rate on the loan and cost and benefits of reinvestment of capital. The portion of the annual profit which the firm returns to the bank by obligations and the value of the total loan are control parameters. Two types of production function: linear and nonlinear are considered and optimal control problems are stated and solved. Attainable sets for the systems are studies analytically and numerically. Dynamics of attainable sets for different parameters of the models will be demonstrated with the use of a computer program written in MAPLE. Economic application will be discussed.

$\longrightarrow \infty \diamond \infty \longleftarrow$

The Dynamics of Energy Balance Models (2292)

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Energy balance climate models are simple empirical models intended to foster a qualitative understanding of the role of crucial feedback mechanism within the climate system. They describe the evolution of a long-term mean of temperature by employing the relevant balance equations for the heat fluxes involved. Typically, the horizontal heat flux is parameterized by a diffusion operator (linear or slow diffusion). This leads to a reaction-diffusion equation or system with or without memory terms depending on the intended complexity. We discuss some fundamental properties of the resulting solution semi-flows.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Distribution of the Eigenvalues of Sturm- Liouville Operators (2319)

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Consider the Sturm-Liouville problem

$$-y'' + q(x)y = \lambda y$$

on $[0, \pi]$ with Dirichlet boundary conditions. Among others we prove the following conjecture of Ashbaugh and Benguria: if $q \geq 0$ is convex then $\lambda_n/\lambda_m \leq n^2/m^2$ for $n \geq m$. The proof is based on some monotonity properties of the Prüfer variables. We investigate some inverse eigenvalue problems as well. For example we describe how many eigenvalues are needed to define the operator.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Reducing Index Method for Differential Algebraic Equations (2017)

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Here, numerical solution of linear differential-algebraic equations (DAEs) with and without constraint singularities is considered and an index reduction technique for them is suggested. In addition for solving them, pseudospectral method with and without domain decomposition is used. Also, It is focused on Hessenberg index 2 and 3 systems and for them, the index reduction method is defined and its use is demonestrated. With providing some examples, the aforementioned cases are dealt with numerically. For more details refer to [1,2,3].

1. Reducing index, and pseudospectral methods for differential-algebraic equations, J. Applied Mathematics and Computation, 140 (2003) 77-90.
2. Reducing index method for differential-algebraic equations with constraint singularities, J. Applied Mathematics and Computation, In Press.
3. An efficient reducing index method for linear differential-algebraic equations,J. Applied Mathematics and Computation, Submitted.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Asymptotic and Qualitative Behaviour of Differential Systems with Almost C^1 Vector Fields (2129)

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This note concerns the asymptotic and qualitative behaviour of solutions of some autonomous systems $x' = f(x)$, where, for a connected open set $D \subset \mathbb{R}^N$ and a Lebesgue measure zero set $D_0 \subset D$, $f \in C(D, \mathbb{R}^N)$ and $f \in C^1(D \setminus D_0, \mathbb{R}^N)$. Particular instances of the above systems are region- wise linear systems. When $D_0 = \emptyset$ and the two largest eigenvalues of $(\frac{\partial f}{\partial x} + (\frac{\partial f}{\partial x})^*)/2$ satisfy $\lambda_1 + \lambda_2 < 0 (\leq 0)$, there are some well known results such as nonexistence of periodic solutions (if D is simply connected) and the existence of $\lim_{t\to\infty} x(t, x_0)$ (if $\gamma^+(x_0)$ is bounded). The aim of the note is to explore the possibility of extending some available results to systems with $D_0 \neq \emptyset$ under a more general condition. As an application the behaviour of a region-wise linear system will be analysed.

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The Principal Floquet Bundle and Exponential Separation for Linear Parabolic Equations (2301)

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Peter Polacik

We consider linear nonautonomous second order parabolic equations on bounded domains subject to Dirichlet boundary condition. Under mild regularity assumptions on the coefficients and the domain, we establish the existence of a principal Floquet bundle exponentially separated from a complementary invariant bundle. Our main theorem extends in a natural way standard results on principal eigenvalues and eigenfunctions of elliptic and time-periodic parabolic equations. Similar theorems were earlier available only for smooth domains and coefficients. As a corollary of our main result, we obtain the uniqueness of positive entire solutions of the equations in question.

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Existence and Approximation of Invariant Manifolds for Nonlinear Evolution Equations (2229)

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An invariant manifold of an evolution equation which can be represented as a graph of a function solves a certain first-order PDE. Conversely, by studying this PDE an invariant manifold can be shown to exist for the evolution equation. Sacker showed existence of solutions to the PDE by an elliptic regularization process. We view the solution as the steady-state of a hyperbolic PDE. The hyperbolic PDE may have many solutions and these solutions comprise a nontrivial atlas for the manifold. Numerical applications will be disscussed.

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Fitted Methods for Boundary Value Problems for Singularly Perturbed Differential Difference Equations (2032)

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The solution of the boundary value problems for singularly perturbed differential equations,i.e.,where the highest order derivative is multiplied by a small parameter, exhibits layer as well as oscillatory behavior. The classical numerical schemes to solve such types of the boundary value problems do not give satisfactory results when the perturbation parameter is sufficiently small.To resolve this difficulty, there are mainly two approaches,namely,fitted operator and fitted mesh methods.In the first approach,the standard finite difference operator is replaced by an operator which reflects the singular nature of the solution.In the second approach,a piecewise uniform mesh is used in such a way that the mesh is fine in the boundary layer region and coarse in the outer region. In this paper, we consider a boundary value problem for singularly perturbed differential difference equation with small shifts of reaction diffusion type.We prove that the method using the fitted operator approach is not parameter-uniform while for the same problem we construct a parameter-uniform method based on the fitted mesh approach.To tackle the terms containing shifts,we use Taylor's series expansion.The parameter-uniform error estimates are obtained for the proposed numerical scheme using fitted mesh approach.In the support of the predicted theory we present some computational results.

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Dynamics of Heterogeneous Populations and the Evolution of Distributions (2533)

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Most population models assume that individuals within a given population are identical, that is, they ignore the fundamental role of variation. By understanding the dynamics within heterogeneous populations, we can see how different growth models and different initial parameter distributions affect what the parameter distribution and the total population size will be at a later time. In recent years some researchers (Ackleh, Fitzpatrick, etc.) considered inhomogeneous models to allow for birth and death rates vary across individuals; theorems of existing and asymptotic of solutions of some models were investigated on the base of ODE in Banach spaces. Here I develop another approach to modeling of heterogeneous populations with distributed vector parameter; I prove that it is equivalent to Cauchy problem for a special system of ODE. As a result, the total population size and current distribution of the vector-parameter could be found in explicit analytical form or computed effectively for different initial distributions. The inhomogeneous models possess some essential new dynamic regimes. The theory is applied to some known biological problems, e.g., a general and adjusted version of Fisher' fundamental theorem of natural selection is proved.

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Approximate First Integrals of Divergence-Free Dynamical Systems in R^3 (2047)

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Approximate generalized symmetries determined by the resonances of divergence-free dynamical systems in R^3 have been considered. A new theorem has been given to find approximate first intgrals (conserved quantities) from the divergence-free approximate symmetries. Furthermore, the result has been applied to a physical system. Invariant curves have been obtained analytically and they have been compared with the numerical ones on the Poincare surface of section.

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Platonic Solids Exhibit Hopf Bifurcation (2123)

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When inscribed inside a sphere of radius R, each of the five Platonic solids with a vortex of strength Gamma placed at each vertex gives rise to an equilibrium solution of the point vortex equations. The equilibria arising from such Platonic solids are then used to generate families of periodic orbits on the sphere which are centered, in some cases, around these equilibria, and in other cases, around more exotic equilibria such as staggered ring configurations. Focussing on the cube as a generic case, four distinct families of periodic orbits are generated. 24 vortices arise as each Gamma vortex of the cube is split into 3 identical Gamma/3 vortices with a splitting parameter theta. The four families of orbits are shown to group into 8,

6, 24 and 6 clusters of 3, 4, 1 and 4 vortices respectively which chase each other around closed orbits on the surface of the sphere. The frequencies are plotted as a function of the splitting parameter through the full range of values. The bifurcation from one orbit family to another in each of the four classes is tracked by following the Floquet multipliers around the unit circle as the splitting parameter is varied.

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The Dynamics of the N Point Vortices on a Sphere (2380)

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In this talk, I will describe the results of the N-vortex problem from my thesis. Beginning with the polyhedral equilibrium solutions of the problem, the Platonic solids are shown to be the F-solutions with the identical vortex strengths and the R-solutions with the opposite strengths in the opposite hemispheres. The frequency of the motion for the R-solutions will then be derived. The F-solutions and the P-solutions arising from the Archimedean solids, prisms and antiprisms will then be enumerated. The bifurcations arising from such equilibrium configurations will be discussed as also the stability of the resulting periodic orbits using the Floquet theory. The motion of the particles and vortices in the tangential velocity field generated by other vortices will be shown to be consistent to the observed motion in the real-world atmospheric systems. The analytical expressions and the reductions of the ODEs in the latter case will be outlined. A new technique showing the generation of the antipodal dipole equilibrium configuration from the two monopoles will be described and this technique will be used to further generate new equilibrium patterns. Reference: PhD thesis (Khushalani, 2004).

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On The Dynamics Of Ratio-dependent Food Chain Models (2430)

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Inkyung Ahn

In this talk, we discuss the positive steady states of certain food chain models with ratio-dependent functional response under Dirichlet boundary conditions. We provide sufficient conditions for the existence of positive steady-state solutions to the model. In addition, the global attractor, the extinction of species, the domino effect and biological control for the system are investigated.

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Existence Result for the Stationary Problem of the Cahn-HilliardEquation: Rigorous Numerics (2599)

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We consider the stationary problem for the modified Cahn-Hilliard equation. In particular, we are interested in proving existence of homoclinic orbits. It is accomplished by means of spectral methods and Banach contraction principle. Together they form a rigorous computer-assisted proof.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Complex Dynamics of Cellular Automata (2254)

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In this work a 2D and 3D simulation of cellular automata will be conducted. Cellular automata are discrete dynamical systems whose behavior is completely specified in terms of local relation. A computer program will be written to simulate the different growth patterns, states, and cycles that occur given changes in different variables. The types of variables will include different rule sets, initial seeds, local relation calculation types, and boundary conditions like periodic and non-periodic. The use of parallel matrices will also be used to track the age of individual cells as well as other functions to track the cellular growth. Color will be used to show the specific ages of individual cells as time progresses.

Different behavior of the variables will result in fixed homogeneous states, fixed non-homogeneous states, chaotic behavior, or complex localized structures.

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Solitary Wave and Wavelet (2005)

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Shikuo Liu

Because wavelet transform is localized, so whether a wavelet is a certain kind of solitary wave, which is also a kind of localized structure? It is shown that homoclinic orbits in iterated functional systems, Harr father wavelet have the solitary wave structure. Moreover, Mexican Cap wavelet and other closed form wavelets, which satisfy linear ordinary differential equations with variable coefficients have also this kind of solitary wave structure. So wavelet is a certain kind of solitary wave.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Multigrid Solver for the Schrödinger Eigenvalue Problem (2378)

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Schrödinger eigenvalue equations are used to describe numerous processes that involve wave propagation. The computational tasks discussed in this talk are particularly inspired by the problems arising in computational chemistry.

In an earlier study, Livshits and Brandt suggested multigrid wave-ray methods for Helmholtz equations with constant and smooth potentials. The methods have a special treatment for the *near-solution* components of the solution, that in traditional methods are the main source of inefficiency. Later we extended this was used to solve the one-dimensional eigenvalue problem for the Schrödinger operator with oscillatory potentials, by developing an algebraic multigrid solver that allows approximations of two independent eigenfunctions that correspond to the eigenvalue in a given range. The solver is very efficient: its cost is of the order of N, the number of unknowns on the target grid.

In the talk, we discuss a multigrid algorithm that allows approximation of all eigenfunctions of the one-dimensional Schrödinger operator. The eigenbasis has a multigrid structure: each coarser grid will have a representation of twice as many eigenfunctions as the finer grid; only the coarsest grid will have a full description of the eigenbasis. If needed, however, each eigenfunction can be easily and inexpensively reconstructed on the finest target grid. The cost of this solver should be extremely low; namely, of order $N \log N$ operations. Such multigrid structures is not only less expensive to calculate and store, but are also very efficient for many tasks, because they allow fast summation.

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Bifurcation of Similarity Solutions to a Boundary Layer Problem (2135)

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The paper considers a continuous moving flat plate with a porous surface which a fluid is injected into or sucked from. Assume that the plate is semi-infinite with a porous surface and that it is moving at a constant speed U_w in the direction parallel to a uniform flow, which is faraway from the plate, with a speed U_∞. Then the laminar flow is governed by the following similarity equation:

$$(1) \qquad \left(|f''(\eta)|^{N-1} f''(\eta)\right)' + f(\eta) f''(\eta) = 0,$$

subject to boundary conditions

$$(2) \qquad f(0) = -C, f'(0) = \xi, f'(+\infty) = 1,$$

where $' = \frac{d}{d\eta}$, $\xi = \frac{U_w}{U_\infty}$ is the velocity ratio, and C is a constant related to suction if it is negative or injection if positive. If $\xi = 0$, then the flat plate does not same move. The case $\xi > 0$ implies that the plate and fluid move in the direction while if $\xi < 0$, they move in opposite directions.

This paper theoretically studies the bifurcation of the solutions for $N = 1$. It presents a proof of the existence of a unique solution to the boundary value problem (1)-(2) for $\xi \in (0, 1)$ and any C and there are at least two solutions for $\xi \leq 0$. The shooting method on the infinite interval $[0, \infty)$, utilized to prove the existence of solutions of the problem, have not been seen elsewhere. When the shooting method is applied, the independent variable is the original similarity variable η and the function is the dimensionless stream function $f(\eta)$. The paper also studies the asymptotic

behavior of the solution as $\eta \to +\infty$. The structure of $f(\eta)$ presented in the paper provides a clearer insight of the flow.

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On Quasi-optimization (2049)

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We study the quasi-optimization problem in connection with convexity and modified semicontinuity conditions. An existence theorem is established under modified conditions.

$$\longrightarrow \infty \diamond \infty \longleftarrow$$

An Existence Result for Periodic Solutions of Nonlinear Planar Autonomous Systems with Small Periodic Perturbations via Fixed Point Theory (2448)

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Paolo Nistri

The talk is devoted to the study of the existence and of the behaviour as $\varepsilon \to 0$ of periodic solutions of a perturbed autonomous differential system in R^2 of the form

$$\dot{x} = \psi(x) + \varepsilon\phi(t, x), \tag{1}$$

where $\psi : \mathrm{R}^2 \to \mathrm{R}^2$ is a continuously differentiable function, $\phi : \mathrm{R} \times \mathrm{R}^2 \to \mathrm{R}^2$ is continuous and T_1-periodic with respect to the first variable and $\varepsilon > 0$ is a parameter. To be specific, we assume that at $\varepsilon = 0$ the autonomous system

$$\dot{x} = \psi(x), \tag{2}$$

has an unique periodic cycle $x_0 = x_0(t),\ t \geq 0$, of least period T_0 satisfying the following conditions:
(A_0) – the linear system $\dot{y} = \psi'(x_0(t))y$ does not have periodic solutions linearly independent with $\dot{x}_0(t)$ and
(A_1) – there exist $l, k \in \mathrm{N}$ such that $\frac{T_0}{T_1} = \frac{l}{k}$, with l and k respectively prime.
This talk addresses the following problems:
1. To provide conditions on the function ϕ which guarantee the existence of an $\varepsilon_0 > 0$ such that the system (2) has a T-periodic solution x_ε, with $T = T(T_0, T_1)$ and $\varepsilon \in (0, \varepsilon_0)$ satisfying the property $x_\varepsilon(t) \to \tilde{x}_0$ *as* $\varepsilon \to 0$, whenever $t \in [0, T]$, where $\tilde{x}_0 = \{x \in \mathrm{R}^2 : x = x_0(t),\ t \in [0, T]\}$ is the limit cycle of (1).
2. To find the explicit value of $\varepsilon_0 > 0$.
3. To investigate the existence of periodic solutions for the system (2) in the case $\frac{T_0}{T_1}$ is an irrational number.
References:
1. M. I. Kamenskii, O. Yu. Makarenkov, and P. Nistri, A new approach in the theory of ordinary differential equations with small parameter, *Doklady Akademii Nauk* **388** (2003), 439-442.
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3. M. Kamenskii, O. Yu. Makarenkov and P. Nistri, Small parameter perturbations of nonlinear periodic systems, *Nonlinearity* **17** (2004) 193-205, to appear. (Available in electronic form).

$$\longrightarrow \infty \diamond \infty \longleftarrow$$

Limit Cycles of Liénard Systems and Applications (2014)

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Sellami Abdelmadjid

We review the main results concerning the limit cycles of planar polynomial systems

$$x = P(x, y)$$

$$y = Q(x, y)$$

We study both small amplitude and large amplitude limit cycles bifurcations of this system . In particular,we study the Liénard system

$$x = y - F(x)$$

$$y = -g(x)$$

We present C.S.Cristopher and N.G.Lloyd result about a lower bound of the numbers of Hilbert.The existence of limit cycle can be proved by using the Poincar-Bendixon theorem.We give applications to predator-prey models.We give tranformation of predator-prey systems into Linard systems.

$$\longrightarrow \infty \diamond \infty \longleftarrow$$

Estimation of the Spectral Density of Dynamics Systems (2579)

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Dans ce travail, nous nous intéressons à l'aspet théorique de l'estimation de la densité spectrale d'un processus dynamique sous l'hypothèse du mélange topologique.
dans un premier temps nous donnons un estimateur à noyau en utilisant le periodogramme, mais cet estimateur n'est pas consistent, d'o le lissage du periodogramme par une fenetre spectrale.Dans un second temps, en se servant de l'inégalité exponentielle, nous montrons la convergence preque sûr de cet estimateur.

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Methodology for Static and Dynamic Analysis of Dynamic Simulation Test Benches (2124)

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Methodology and algorithms for static and dynamic analysis of dynamic simulation test benches are considered.

The dynamic simulation test benches are the spatial mechanisms, which have several degrees of freedom. They are designed for simulation of aircraft motion in laboratory conditions.

The test benches made from composite materials and magnesium are under consideration. Modelling and research for composite structures are more complex as compared with structures made from homogeneous materials since one must take into account different physical and mechanical properties and orientations of layers of multi-layered composite. Sometimes it is difficult to manufacture composite reduction gears, bearings and other members. Therefore it is important to consider the problems of contact interaction between homogeneous and composite materials.

Methodology and algorithms for determining frequency characteristics and stress-strain state of various constructions of test benches taking into account the difference in properties and orientations of composite layers are developed.

The dynamic simulation test benches are modelled by a set of multi-layered shell and 3D finite elements. To solve the problem we deal with Lagrange's differential equations, the CAD CATIA software, the finite element method, and several analytical methods.

Finally, we obtain the finite element approximation of the dynamic simulation test benches, natural frequencies and modes, and stress-state statement of these test benches under operating static and dynamic loadings.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Mathematical Modeling of HIV Pathodynamics (2335)

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A Clinically plausible mathematical model is constructed depicting HIV pathodynamics during the pre-latency , latency and the post-latency regime.This model incorporates the HIV interactions with the the patient's immune system in the absence of external drug therapy . The model equations are analyzed using the principles of Hartmann-Grobmann linearized stability , Dynamical Systems Theory ,and Hopf-Andronov-Poincare bifurcation. Some mathematical criteria are derived for the pathological scenarios of viral persistence , immune system reconstitution and viral annihilation . Investigative computer simulations are performed under various clinically plausible parametric configurations.

$\longrightarrow \infty \diamond \infty \longleftarrow$

Stability Robustness for Rigid-Rotor Model of Journal Bearings (2007)

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Antonio Garcia

The stability of rotor motion supported by bearings is a central problem in the proper design of rotor bearing systems. The turbo machinery design in the preliminary stage is usually based on some idealized

values of rotor dynamic coefficients describing (in linear approximation) the rotor dynamic. Nevertheless, the real values of rotor dynamic coefficients are usually different from their idealized values. Changes of bearing clearance, lubricant temperature and associated viscosity, out of roundness of the circular bearing and approximating assumptions while solving Lubrication equations are some immeasurable variations affecting proper calculation of the threshold speed of stability. All these types of small variations can be conveniently described as immeasurable disturbances of the coefficients appearing in the system equations of motion. The disturbances of rotor dynamic coefficients can be characterized in different ways, the most popular ones are stochastic and min-max descriptions. We shall use min-max description of relative errors in the determination of bearing rotor dynamic coefficients. As a rule the required accuracies in determination of stiffness and damping coefficients are different, therefore this difference is taking into account by a special coordinating and coupling factor. Our mathematical instrument used to estimate disturbances is the Kharitonov Theorem on stability robustness. Different estimations of disturbance magnitudes which ensure the system stability for a rigid rotor model are obtained and graphs showing the dependence on the eccentricity of maximal admissible value of relative errors for short and long bearing models are presented as well. Therefore some illustrating examples are given.

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Stability of Some Polinomial Equations with Delay (2008)

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The systems with delays are of great theoretical interest and form an important class as regards their applications. One of important problem related to the equations with delay is the study of their stability. The stability of linear autonomous equations with delays was studied in details by different authors by specific methods. But these methods can not be used for non autonomous linear or nonlinear equations. In these more general cases the Liapunov direct method can be used for stability investigation. Krasovskii suggested the use of functionals defined on retarded equations' trajectories instead of Liapunov functions and proved general stability theorems based on the use of functionals. Now such functionals are commonly called Liapunov-Krasovskii functionals. Another important class of functionals used in stability study of different functional differential equations is the class of degenerated functionals. The degenerated functionals are non negative but not positive definite functionals. There exists a little number of equations with delay whose stability conditions are expressed directly in terms of their coefficients. The most studied are autonomous and non autonomous linear equations for which different sufficient conditions of stability depending or not on delay are established. If the nonlinear equation contains linear terms its stability can be studied by use of the theorem on stability in the first approximation. The stability problems for nonlinear equations without linear terms are more complicated and not studied at present. Here scalar equations of third, fifth and arbitrary odd order with delays but without linear terms are studied. Using Liapunov-Krasovskii or degenerated functionals some sufficient conditions of asymptotic stability depending or not on delays for different equations of such type are derived. These stability conditions are expressed directly in terms of equations coefficients. It facilitates their use for different applications.

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Hopf Bifurcation for a Class of Differential Equations with Two Delays (2034)

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In this paper, we deal with Hopf Bifurcation for a differential equation with two delays, when the parameter of bifurcation is one of the two delays. The method used here is based on the center manifold reduction and the h_asymptotic stability theory related to the Poincaré procedure. We also point out, through some examples, the effect of the second delay on the qualitative behaviour of the system.

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Equipartition Times in Fermi–Pasta–Ulam System (2440)

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We investigate with numerical methods the celebrated Fermi–Pasta–Ulam model, a chain of non–linearly coupled oscillators with identical masses. We are interested in the evolution towards equipartition when energy is initially given to one or a few modes.

Using the spectral entropy as a numerical indicator we have a strong suggestion that the relaxation time to equipartition increases exponentially with an inverse power of the specific energy. Such a scaling appears to remain valid in the thermodynamic limit.

A further investigation is then performed using other indicators, like Lyapunov exponents and their variants, and Poincaré sections. A complex scenario, which will be presented in the talk, emerges also from these experiments, even though they can hardly be carried out for large number of particles, respectively for computational limitations, and obvious geometrical restrictions.

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Investigation of an Asymptotic Solution of a Semi-Linear Differential Equation in an Non-Stationary Space-Time (2351)

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This paper investigates the mathematical conditions under which the asymptotic solution of a semi-linear differential equation approaches the solution of the corresponding linear differential equation. The mathematical model such setup, enables to construct a physical model of quantum fields propagating in a classical time-dependent curved space- time. This physical model can be used to study the dynamics of a star undergoing gravitational collapse.

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Criteria for Disfocality and Disconjugacy for Third Order Differential Equations (2442)

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In this paper, lower bounds for the spacing $(b-a)$ of the zeros of the solutions and the zeros of the derivative of the solutions of third order differential equations of the form

$$y''' + q(t)y' + p(t)y = 0 \quad (*)$$

are derived under the some assumptions on p and q. The concept of disfocality is introduced for third order differential equations (*). This helps to improve the Liapunov-type inequality, when y(t) is a solution of (*) with (i) $y(a) = 0 = y'(b)$ or $y'(a) = 0 = y(b)$ with $y(t) \neq 0,\ t \in (a,b)$ or (ii) $y(a) = 0 = y'(a),\ y(b) = 0 = y'(b)$ with$y(t) \neq 0,\ t \in (a,b)$.

If y(t) is a solution of (*) with $y(t_i) = 0,\ 1 \leq i \leq n,\ n \geq 4,\ (t_1 < t_2 < ... < t_n)$ and $y(t) \neq 0,\ t \in \bigcup_{i=1}^{i=n-1}(t_i, t_{i+1})$, then lower bound for spacing $(t_n - t_1)$ is obtained. A new criteria for disconjugacy is obtained for (*) in $[a,b]$.

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A Stochastic Differential Geometry Approach to the Schroedinger Equation (2418)

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We present a derivation of the Schroedinger equation in terms of stochastic differential equations associated to a generalized laplacian derived from a gauge-theoretical structure associated to Cartan connections, with torsion restricted to a trace 1-form which contains both the logarithmic differential of the wave function, but also the electromagnetic potentials appearing as external fields. Thus, in this setting, non relativistic quantum mechanics, becomes unified with space-time geometrical structures. We introduce further, the random symplectic structure associated to the Schroedinger equation, deduced from the above approach, and thus it is a very different approach to quantization that the geometric quantization approach due to Souriau, Kostant and others in the decade of the seventies. This work is related to our geometrical-stochastic approach to the representations of the Navier-Stokes equations, presented another contribution to this Conference.

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The Random Symplectic and Differential Geometry Approach to the Navier-Stokes Equations (2628)

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We present the random geometry that leads to the representations of the invariant Navier-Stokes equations on smooth compact manifolds. We realize these representations by sequences of classical (at almost all times) flows that converge in probability to the exact representations. We construct the random symplectic geometry associated to these representations, and the random Poincar-Cartan invariants of the Navier-Stokes flows. We retrieve, in the singular limit of kinematical viscosity, the symplectic approach due to V.Arnold and further developed by D.Ebin and J. Marsden to the Euler equations. We extend these results to the kinematic dynamo equations of magnetohydrodynamics.

This work follows the authors contributions

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Equivalence of Nonautonomous Differential Equations in a Banach Space (2553)

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We find sufficient conditions under which the nonautonomus differential system in the Banach space $\mathbf{X} \times \mathbf{Y}$ is simpler than the given one in terms of decoupling and linearization. The second system splits into two parts. The first part of them does not contain the variable $y \in \mathbf{Y}$, while the second one does not contain the variable $x \in \mathbf{X}$ and is linear. This result allows one to replace the given system by a much simpler one. Relevant resuls concerning partial decoupling and simplifying of the nonautonomous differential equations are given also.

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Mathematical Modeling of Cell Population (2081)

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Results of mathematical modeling carried out for dynamics of a non-uniform cellular population of multi-cellular organisms based on the functional-differential equations are considered. Dynamics of the interconnected groups which are consisting of dividing, growing, differentiating, fulfilling of specific functions and aging cells [1,2] is quantitatively described.

Qualitative analysis of the functional-differential equations for considered cellular population (by research of critical points, constructions of phase and parametrical portraits) has shown presence of trivial attractor (O) with the limited basin and non- trivial attractor (F) with infinite basin in the first quadrant of phase space [3,4].

Attractor F has a steady state which can be broken with appearance of Poincare type limit cycles. In determined range of parameters values F turns in strange attractor with the advent of irregular fluctuations. In some cases these fluctuations can be failed to trivial attractor (there is an effect of "black hole"). Quantitative analysis of irregular fluctuations area, based on the analysis of Kolmogorov's entropy dynamics using PC, has shown its heterogeneity and presence of small regions ("r-windows") with regular fluctuations.

Results of the work are used for the regularities analysis of cotton growing and development (grant FPFI AS RUz 41-98) and for the toolbox development for information technology in gene, cellular engineering and biotechnologies (grant P-20.16 TSNT RUz).

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Treatment on Enhanced Friction Constrained Motion (2350)

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Roland Glowinski

Refining dynamical system models with dry friction, particularly at relatively very low velocities (i.e. when friction forces dominate the dynamics) is essential to simulate and predict real life results. Applications of these models including the design of high fidelity software for real-time simulation of the remote manipulator systems on the space shuttle and space station, in orbit camera inspection of tile damage, and visco-plastic particulate flow related to drilling technologies in oil industry processes.

Here we study and analyze such dynamical systems involving differential equations and inequalities with a family of numerical schemes enhanced with a multiplier. The treatment, including an implicit-explicit scheme coupled with operator-splitting techniques and a dynamical regularization procedure, essentially leads to strong convergence of the friction multiplier, as well as the solutions to the dynamical systems.

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Numerical Simulation for Ferroresonant Circuit (2565)

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Gopal Gajjar

Ferroresonance is a non-linear phenomenon, which exhibits in power system network. Generally, this abnormality is cause by a presence of saturable ferromagnetic inductor in a circuit along with capacitance and low value of damping resistor. The mentioned phenomena arise in a circuit in steady state as well as transient state. In this paper, we have made an attempt to develop a mathematical model of the circuit, which is susceptible to ferroresonance in steady state condition based on work of Bental et al [1]. Stiff ode solvers has been applied to solve the mathematical model. We have also made an attempt to apply the Galerkin method (see [1]) to solve system of first order ordinary differential equations. At the end we have presented the simulation for characteristic ferroresonant waveforms in two different forms namely time domain and phase plot analysis. Simulations also identify the domain of damping resistor under which the circuit do not exhibit ferroresonance. This approach can be applied to design a circuit such that ferroresonance can be avoided. The same analysis can be seen in [2] for simplified circuit.

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$\longrightarrow \infty \diamond \infty \longleftarrow$

Oscillation of a Class of Superlinear Neutral Difference Equations of Higher Order (2009)

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Sufficient conditions are obtaind under which all solutions of

(1)
$\triangle^m[y(n)+p(n)y(n-\tau)]+q(n)G(y(n-\sigma)) = 0, n \geq 0,$

oscillate, which is the discrete analogue of

(2) $[y(t)+p(t)y(t-\alpha)]^{(n)}+q(t)G(y(t-\beta)) = 0, t \geq 0.$

(1) is studied in J. Math. Anal. Appl. 284(2003), pp. 756 - 774, where G is sublinear. Here, an attempt is made to study the oscillatory behaviour of (1), when G is superlinear and p(n) lies in different ranges with odd and even m.

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Discrete Approximations to Neutral Differential Inclusions (2202)

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This talk focuses on the convergence of discrete approximations to optimization problems governed by neutral functional differential inclusions. The discrete approximations are constructed using the Euler finite difference method and the convergence of discrete approximations is discussed.

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Controllability for Semilinear Integrodifferential Equations (2203)

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This talk focuses on the approximate controllability and the approximate null controllability of a class of control systems governed by semilinear integrodifferential equations in Banach spaces. It is proved that the approximate controllability and the approximate null controllability for the control system under some easy verified assumptions are implied by the approximate controllability and the approximate null controllability of its corresponding linear control system.

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Invariant Manifold Theory and Viscoelastic Structures (2122)

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I study the nonlinear dynamics of heavy rigid bodies carried by light, deformable, viscoelastic bodies. The equations for such problems are a nonlinear partial differential equation describing the motions the deformable body coupled to a dynamical boundary condition describing the motions of the rigid attachment. After discretizing the governing equations, I treat the problem by introducing a small parameter that measures the ratio of the mass of the deformable body to the mass of the rigid attachment. I then apply invariant manifold theory to analyze the long-term dynamics of the resulting singular perturbation problem. I prove the existence and normal hyperbolicity of a low-dimensional inertial manifold for the unperturbed system and establish rigorously the connection between the dynamics on this inertial manifold and the long-term dynamics of the perturbed system.

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Necessary and Sufficient Conditions of Semi-uniform Ergodic Theorems and Their Applications (2055)

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Zuohua Zheng
Zhiming Zheng

Uniform bounds on growth rates, as in the definition of hyperbolic sets, and non-uniform bounds as in the theory of Liapunov exponents are quite different in nonlinear dynamics. It had been established one-side uniform convergence in both the Birkhoff and sub-additive ergodic theorems under conditions on growth rates with respect to all the invariant measures of a system. In this paper we show these conditions are necessary and sufficient. These results are applied to study quasiperiodically forced systems and present some meaningful geometric properties of invariant sets of such systems. We also show that any strange compact invariant set for a $\mathcal{C}^1$ quasiperiodically forced system must support an invariant measure with a non-negative maximal normal Liapunov exponent. Furthermore the constrains on conditions of some theorems derived here are weaker and more easily verified than the known ones. Uniform bounds on growth rates, as in the definition of hyperbolic sets, and non-uniform bounds as in the theory of Liapunov exponents are quite different in nonlinear dynamics. It had been established one-side uniform convergence in both the Birkhoff and sub-additive ergodic theorems under conditions on growth rates with respect to all the invariant measures of a system. In this paper we show these conditions are necessary and sufficient. These results are applied to study quasiperiodically forced systems and present some meaningful geometric properties of invariant sets of such systems. We also show that any strange compact invariant set for a $\mathcal{C}^1$ quasiperiodically forced system must support an invariant measure with a non-negative maximal normal Liapunov exponent. Furthermore the constrains on conditions of some theorems derived here are weaker and more easily verified than the known ones.

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Julia Sets of Two Pernutable Entire Functions (2113)

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In the talk, some recent results on the relationships of the Fatou sets of two permutable functions will be addressed. Particularly, we show that for a certain classes of entire functions, the Fatou set for two such functions are the same.

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Uniqueness, Global Existence and Stability of Fractional Differential Equations (2000)

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Gao G

Consider the fractional differential equation

$$D^{\alpha}x(t) = f(t, x(t))$$

where $\alpha \in [0, 1]$ and $f(t, x(t))$ is a given function. We obtain a sufficient condition for the uniqueness and global existence of this equation, which improves previously known results.Forthermore, we proved a theorem for stability of this equation first.

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Wave Map with Potential and Hypersurface Flow (2594)

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Jianping Fang
Lanjun Li

The simplified equation of the dynamics of weak ferromagnets magnetization is related to the hyperbolic conservation laws with singular relaxation terms, which converges to the hypersurfaces flow as the parameter $\epsilon \to 0$.

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Regularity of the Solutions for Nonlinear Schrödinger Equations with Potentials Superquadratic at Infinity (2059)

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We study the regularity of the solutions for the initial value problem of the nonlinear Schrödinger equations with potentials superquadratic at infinity when the initial value has higher regularity than L^2 function.

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Generalized Matrix Algebras and Their Applications (2209)

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Xijing Guo

The relations between the radicals of path algebras and connectivity of directed graphs are given. The relations between radicals of generalized matrix rings and Γ-rings are given. All the coquasitriangular structures of group algebra kG are found when G is a finitely generated abelian group.

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