Abstract of all talks

In the multiple authors case, the name with $*$ is the speaker.

On the dynamics of Plateau networks, diffused and sharp

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Abstract: The motivation of this work comes from interfaces moving by (mean) curvature and satisfying Plateau angle conditions. The solutions we study model the core of the junctions for the associated diffused interface problem. We will present a simple model result in this direction. This is joint work with G.Fusco, and related to other works with S. Betelu, Xinfu Chen, and A. Freire.

Recent Developments in Direct and Inverse Scattering of Electromagnetics

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Dimensions of average conformal repeller

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Abstract: In this paper, average conformal repeller is defined, which is generalization of conformal repeller. Using thermodynamic formalism for sub-additive potential defined in [Cao Yongluo, Feng Dejun, Huang Wen: The thermodynamic formalism for sub-multiplicative potentials. To appear in Discrete and Continuous Dynamical Systems(A)(2007)], Hausdorff dimension and box dimension of average conformal repellers are obtained. The map f is only needed C^1, without additional condition.

Sign changing solutions for superlinear boundary value problems

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Abstract: Using the geometric structure of the Nehari manifold, existence and multiplicity of solutions to superlinear boundary value problems will be discussed. In particular, we will show cases where a Dirichlet problem has a solution that changes sign exactly once.

Traveling Wave and Its Spectral Analysis for Nonlocal Evolution Systems

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Abstract: In this talk we examine the existence, uniqueness and stability of monotone traveling waves for a broad class of nonlocal bistable evolution system. we will also study the spectrum of the operator obtained by linearizing about such a traveling wave and hence show that these waves are exponentially asymptotically stable, up to translation.

Double positive solutions of boundary value problems for p-Laplacian impulse functional dynamic equations on time scales

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Abstract: Let T be a closed nonempty subset of R, and let T have the subspace topology inherited from the Euclidean topology on R. In some of the current literature, T is called a time scale (or measure chain). For notation, we shall use the convention that,

for each interval J of R, J will denote the time scales interval, that is, $J := J \bigcap T$. There is currently much activity focused on time scales. Included in this activity, the theory of dynamic equations on time scales has received much attention in recent years. This theory unifies existing results in differential and finite difference equations, and provides powerful new tools for exploring connections between the traditionally separated fields. On the other hand, the impulsive differential equations, which arise in physics, population dynamics, economics, and so on , have become more and more important in mathematical models of real process. And the boundary value problems for impulsive differential equations and impulsive difference equations have received special attention from many authors in recent years. In this paper, we are concerned with the existence of positive solutions of the boundary value problem for the following p-Laplacian impulsive functional dynamical equations on a time scale.

Mathematical Issues related to a Nonlinear Circuit

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Abstract: We present a nonlinear circuit used in modulation schemes for analog and digital signals. Mathematical issues in this application are considered. In particular, we will show how bifurcation theory in singularly perturbed problems is applied to signal processing. We will also discuss qualitative behaviors when white noise and couplings are introduced to the system.

Stability Analysis of Fractional Differential System with Time-delays

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Abstract: This paper further studies the stability of fractional linear delayed systems. Using the technique of Laplace transform, we introduce the definition of characteristic equation of fractional linear systems with multi-delay and, as its particular cases, the definition of characteristic equation of fractional linear system without delay is naturally presented. By studying the characteristic equation of fractional linear systems with multi-delay, the

sufficient conditions are attained for the Lyapunov globally asymptotical stability of the general multi-delay fractional linear systems. This result generalizes the result of Chen & Moore in [Nonlinear Dynamics 29(2002)191]. Moreover, from the characteristic equation of fractional linear system without delay, we can easily get its stability region. Finally, the theoretical results are applied to the synchronization of fractional multi-delay coupled Duffing oscillators.

Approximate study to the Fisher Equation and applications in population dynamics

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Abstract: There is the widespread existence of wave phenomena in physics, chemistry and biology. This clearly necessitates a study of traveling waves in depth and of the modeling and analysis involved. In the present paper, we study a nonlinear reaction-diffusion equation, which can be regarded as a generalization of the Fisher equation. This equation is used as a density-dependent diffusion model, in the one-dimensional situation, for studying insect and animal dispersal with growth dynamics, and as a genetic model arising from the classical theory of population genetics and combustion. We focus on the analysis of traveling waves and present an approximate wave solution by means of the a domain decomposition method and the Lie symmetry method. The results will help us to understand and anticipate how the population disperses to regions of lower density more rapidly as the population gets more crowded or environmental factors and geographical resources get changed.

A variational model for microstructure generation

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Abstract: We analyze the minimization problem

$$\min_{u\in W^{2,2}(0,1)} F^\epsilon(u) + \frac{\mu}{2\epsilon^2}\int_{(0,1)}(u-\bar{u})^2 dx, \tag{1}$$

where $\bar{u}$ is a given function , $0 < \mu$, $0 < \epsilon << 1$ are parameters and $F^\epsilon(u) := \int_{(0,1)}(\frac{\epsilon^2}{2}u_{xx}^2 + \phi(u_x))dx$. We are interested in the case of a non convex energy density $\phi : \mathbf{R} \to [0, +\infty)$. Numerical simulations indicate that, in time scales of $O(\epsilon^2)$, the gradient system defined by F^ϵ

$$\begin{aligned} u_t &= -\epsilon^2 u_{xxxx} + (\dot{\phi}(u_x))_x, \\ +BC &\quad , \quad u(.,0) = \bar{u}, \end{aligned} \tag{2}$$

generates a fine microstructure in certain subregions of $(0,1)$ that are determined by the initial datum $\bar{u}$. The parameter μ in (1) can be interpreted as the inverse of a slow time τ defined by $t = \epsilon^2\tau$. Therefore one can expect that, for small $\epsilon > 0$, minimizers $u^{\epsilon,\mu,\bar{u}}$ of (1) exhibit a structure similar to the one shown , for $\tau = \frac{1}{\mu}$, by the solution $u(., \epsilon^2\tau, \bar{u})$ of (2) in the numeric experiments. We present several results that confirm the above expectation.

On the Positive Solutions of Second Order Sturm-Liouville-like Boundary Value Problems

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Abstract: In recent years much attention was focused on the so-called nonlocal boundary value problems. However, till now most work in this field is done for some comparatively special cases, Dirichlet-like and mixed-like boundary conditions. To get the existence of positive solutions to the Sturm-Liouville-like problems, some additional requirements must be put on the nonlinear items appeared in the differential equations. For the Sturm-Liouville-like problems, we divide them into three types and search conditions for each case to make the operators in equivalent abstract equations be cone-to-cone mappings. After doing that, a series of theorems on the existence of positive solutions are obtained for each type of the problems.

Invariant Tori of Full Dimension in a Nonlinear Schrödinger Equation

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Abstract: In this paper, one-dimensional nonlinear Schrödinger equation

$$\mathrm{i}u_t - u_{xx} + mu + f(|u|^2)u = 0$$

with the periodic boundary condition is considered, where f is a real analytic function in some neighborhood of the origin with $f(0) = 0$, $f'(0) \neq 0$. It is proved that for each given constant potential m, the equation admits a Whitney smooth family of small–amplitude, time almost–periodic solutions on full set of frequencies. The proof is based on Birkhoff normal form reduction, scaling skills and an improved KAM theorem. Thus, we give an affirmative answer to the open problem in [Pöschel, Erg. Th. Dynam. Syst., 22(2002), 1537–1549].

The dynamics and bifurcations of the two half-plane piecewise rotation system

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Abstract: In this talk (joined work with Anthony Quas, Michael Boshernitzan) we discuss the following elementary system. Let $T : \mathbf{C} \to \mathbf{C}$ be a map that acts as rotation on the upper and lower half planes. Cases of non-invertible T give rise to attractors and repellers. Attractors undergo interesting bifurcations and give rise to explosions of infinitely many discs. An invertible T (when the two half-planes do not overlap) has periodic points in every neighborhood of infinity and even though T preserve an infinite measure, it is still conservative. A measure theoretic criteria for attractors have recently been obtained by Xin-Chu Fu et al.

Exact Turbulence Solution of the Euler's equation for the Plane Flow without External Force

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Abstract: Based on the conception "pseudo-potential" of incompressible flow in the plane, which was posed by [Yu Weiwei and Guan Ke-ying, A derivation of Burgers-KdV

equation from Navier-Stokes equation, to appear], we give an exact solution to the Euler's equation

$$\frac{\partial \mathbf{v}}{\partial t} + (\mathbf{v}\nabla)\mathbf{v} = -\frac{1}{\rho}\nabla \mathrm{p} + \mathbf{f},$$

where the external potential force $\mathbf{f}$ can be arbitrarily given. This solution describes infinitely many non-stationary vortexes distributed periodically on the whole plane and the Brownian motion appeared in the neighborhood of the edge between these vortexes.

Limit cycles near homoclinic and heteroclinic loops

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Abstract: In the study of near-Hamiltonian systems, the first order Melnikov function plays an important role. It can be used to study Hopf, homoclinic and heteroclinic bifurcations, and the so-called weak Hilbert's 16th problem as well. The form of expansion of the function at the Hamiltonian value corresponding to a homoclinic loop has been known with the first three coefficients. In this paper, our main purpose is to give an explicit formula to compute the first four coefficients for both homoclinic and heteroclinic cases, where the formula for the fourth coefficient is new, and to give a way to find limit cycles near the loops by using these coefficients. As an application, we consider polynomial perturbations of degree 4 of quadratic Hamiltonian systems with a heteroclinic loop, and find 3 limit cycles near the loop.

The Stochastic Bifurcation of a Speculative Asset Pricing Model

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Abstract: Within the framework of the heterogeneous agent paradigm, we establish a stochastic model of speculative price dynamics whose market price equilibria can be characterized by the invariant measures of a random dynamical system. By conducting a stochastic bifurcation analysis, we examine the market impact of speculative behaviour. We show that the market equilibrium price can be characterized by a unique and stable

invariant measure when the activity of the speculators is below a certain critical value. If this threshold is surpassed, the market equilibrium can be characterized by two invariant measures, one stable and the other unstable. In addition, the corresponding stationary measure displays a significant qualitative change near the threshold value. This qualitative change is further analyzed by using a stochastic approximation method.

A Functional Reaction-Diffusion Problem from Climate Modeling

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Abstract: This talk is based on joint work with J.I. Díaz and Lourdes Tello. Simple heuristic climate models lead to reaction-diffusion equations on the 2-sphere with slow diffusion and memory. Additionally, the reaction part exhibits a jump discontinuity (at the snow line) in case of so-called Budyko-type models. Finally, a Babuška-Duhem hysteresis accounts for a frequent repetition of sudden and fast warming followed by much slower cooling as observed from paleoclimate proxy data. Global existence and the existence of a trajectory attractor will be discussed for the resulting system.

Eigenvalue Problem, Asymptotic Behavior of Solution, and Uniqueness of Mono-stable Traveling Wave for Class of Time Delayed Reaction-diffusion Systems

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Abstract: We investigate the property of eigenvalues and corresponding eigenvectors for a class of second order linear system of delay differential equations that plays a crucial role to study the asymptotical behavior of a heteroclinic solution for a nonlinear system of delay differential equations that corresponds to traveling waves for a class of time delayed reaction-diffusion equations. In particular, we prove that, for a certain class of reaction-diffusion equations with time delay, the mono-stable traveling wave is unique and is monotone (relative to a given wave speed).

The Spectrum of Chaotic Time Series

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Abstract: The question of spectral analysis for deterministic chaos is not well understood in the literature. In this paper, using iterates of chaotic interval maps as time series, we first analyze the mathematical properties of the Fourier series of these iterates. The key idea is the connection between the total variation and the topological entropy of the iterates of the interval map, from where special properties of the Fourier coefficients are obtained. Various examples are given to illustrate the applications of the main theorems. Then we perform multi-resolution analysis by using wavelet coefficients and characterize some necessary and sufficient conditions for the occurrence of chaos by the exponential growth with respect to the number of iterations n of certain sums of the wavelet coefficients.

The complete classification on a model of two species competition with an inhibitor

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Abstract: Hetzer and Shen [1] considered a system of two-species Lotka-Volterra competition model with an inhibitor, investigated its long-term behavior and proposed two open questions: one is whether the system has a nontrivial periodic solution; the other is whether one of two positive equilibria is non-hyperbolic in case that the system has exactly two positive equilibria. The goal of this paper is first to give these questions clear answers, then to present a complete classification for its dynamics in terms of coefficients. As a result, all solutions are convergent as t goes to infinity.

About a stability conjecture for the dynamics of mechanical systems with shocks and friction

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Abstract: This lecture deals with some properties of the trajectories of systems of particles which are forced to remain on one side of an obstacle, so that the trajectories involve shocks together with contact and friction conditions. We shall recall that these conditions imply that the differential equations of the dynamics must be understood in the sense of measures and we shall give some results concerning the set of equilibrium states and the smoothness of the trajectories.
We shall observe in particular that, among very large sets of equilibrium solutions, a generic situation is such that an equilibrium state involves some particles strictly stuck by friction, others in imminent sliding, and still others out of contact. For this situation, a new notion of stability specially adapted to systems with Coulomb friction will be introduced. Whereas classical stability results in mechanics concern perturbations of the initial data in a classical phase space, we study here the effects of a perturbation of the external forces. The main point of the lecture is to back up a conjecture, by closed-form calculations in the case of simple systems and by numerical computations for more complex systems.
The statement of the conjecture is the following:
Let a discrete system with a finite number of degrees of freedom be submitted to nonregularized unilateral contact and Coulomb friction. Assume the data are such that there exists an equilibrium state in which some points are strictly stuck while the others are in imminent sliding. Then, the trajectory produced by any sufficiently small perturbation of the forces leads to a new equilibrium where the number of strictly stuck particles is larger than before the perturbation.
If the system has a nonzero stiffness matrix and the perturbation is constant, then we shall establish that for small size systems the final state is reached in finite time and is such that all the particles are strictly stuck.

References

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[2] S. Basseville and A. Léger, Stability of equilibrium states in a simple system with unilateral contact and Coulomb friction. *Archive Appl. Mech.*, Vol. 76, 7/8, 403-428, 2006.

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The Period Function of Hyperelliptic Hamiltonian of Degree Five

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Abstract: We provide a criterion to determine the convexity of the period function for a class of planar Hamiltonian systems. As an application we prove that the period function of all hyperelliptic Hamiltonians of degree five has at most one simple critical point. More precisely, if the period annulus surrounds only one non-degenerate singularity, then the period function is monotone; otherwise (i.e. the period annulus surrounds 3 singularities, taking into account the multiplicities), the period function has exactly one critical point.

Dynamical Models for Interacting Wild and Transgenes Mosquitoes

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Abstract: To prevent the transmission of malaria and other mosquito-borne diseases, genetically-altered (transgenic) mosquitoes, that are resistant to malaria infection, become an effective weapon. To study the impact of releasing transgenic mosquitoes into the field of wild mosquitoes, we formulate mathematical models of interacting mosquitoes populations, based on a system of differential equations. Density-dependent vital rates are considered and, in particular, Allee effects are incorporated in the functional mating rates. Dynamics of these models are explored by investigating existence and stability of boundary and positive equilibria. The models exhibit richer dynamics which are demonstrated by numerical simulations.

On Morse theory for random dynamical systems

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Abstract: In this talk, we will try to understand the Morse theory for Random Dynamical Systems and its applications to symplectic topology which may lead to some topological invariants.

Lyapunov Exponents and Invariant Manifold for Random Dynamical Systems in Banach Spaces

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Abstract: In this talk , I will report a recent work on the multiplicative ergodic theorem for infinite dimensional random dynamical systems in Banach space and its application to a stable unstable manifold theorem.

Competition-Diffusion Systems with a Refuge

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Abstract: In this paper, a model composed of two Lotka-Volterra patches is considered. The system consists of two competing species X, Y and only species Y can diffuse between patches. It is proved that the system has at most two positive equilibria and then that permanence implies global stability. Furthermore, to answer the question whether the protection zone is effective to protect Y, the properties of positive equilibria and the dynamics of the system are studied when X is a much stronger competitor, and we get a global result.

Flow of incompressible viscoelastic fluid

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Abstract: Here we discuss some recent progress on global existence and stability near the equilibrium of the Oldroyd model for the incompressible viscoelastic fluids.

Gearhart-Prüss Theorem and linear stability for Riemann solutions of conservation laws

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Abstract: In this talk, we will review the Hille-Yosida Theory, Paley-Wiener Theorem and Gearhart-Prüss Theorem on the asymptotic behavior of semigroups. We consider the spectral and linear stability of of the Riemann solutions with multiple Lax shocks for systems of conservation laws $u_\tau + f(u)_\xi = 0$. Using the self-similar change of variables $x = \xi/\tau, t = ln(\tau)$, Riemann solutions become stationary to the system $u_t + (Df(u) - xI)u_x = 0$. In the space of $O((1 + |x|)^{-\eta})$ functions, we show that if $\Re\lambda > -\eta$, then λ is either an eigenvalue or resolvent point. Eigenvalues of the linearized system are zeros of the determinant of a transcendental matrix. On some vertical lines in the complex plane, there are *resonance values* where the determinant can be arbitrarily small but nonzero. A $C0$ semigroup is constructed and using the Gearhart-Prüss Theorem, we show that the solutions are of $O(e^{\gamma t})$ if γ is greater than the largest real parts of the eigenvalues and the resonance values. We study examples where Riemann solutions having two or three Lax-shocks. We will discuss how the linear stability can be used to determine the nonlinear stability of Riemann solution with shocks.

Bifurcation analysis of a plantherbivore model with toxin-determined functional response

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Abstract: We explore the impact of plant toxicity on the dynamics of a plant-herbivore interaction by studying a mathematical model that includes a toxin-determined functional response. A wide variety of dynamics may occur due to the interplay Holling Type 2 dynamics and the effect of the plant toxicant. These dynamics include the occurrence of bi-stability, in which both a periodic solution and the herbivore-extinction equilibrium are attractors, as well as the possibility of a homoclinic bifurcation.

Nodal Sets of Solutions of Equations Involving Magnetic Schrodinger Operator in Three-Dimensions

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Abstract: It is well-known that the complexity of the nodal set of a function mainly comes from the singular set on which both the function and the gradient vanish. The singular set of a real-valued solution of a linear elliptic equation has been well investigated. For a complex-valued solution of a linear equation involving a magnetic Schrodinger operator, the structure of the nodal set has not been well investigated yet excepted in the two-dimensional case. In this paper we show that the singular set of such a solution in a three-dimensional domain is countably 1-rectifiable. The functions considered in this paper include the order parameter in the Ginzburg-Landau theory of superconductivity, and the eigenfunctions of the magnetic Schrodinger operator.

Periodic solutions for non-smooth Hamiltonian systems

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Abstract: In this talk, we consider the existence and infinity of periodic solutions for two kinds of non-smooth Hamiltonian systems: sub-linear seconder order Hamiltonian

systems with impacts and super-linear impulsive seconder order equations. Non-smooth critical point theory, Poincaré-Birkhoff twist theorem, topological degree and some phase-plane analysis are used in our arguments.

Droplet solutions of a 2D free boundary problem from diblock copolymer morphology

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Abstract: The Ohta-Kawasaki density functional theory of diblock copolymers gives rise to a nonlocal free boundary problem. In a proper parameter range an equilibrium pattern of many droplets is proved to exist in a general planar domain. A sub-range is identified where the multiple droplet pattern is stable. Each droplet is close to a round disc. The boundaries of the droplets satisfy an equation that involves the curvature of the boundary and a quantity that depends non-locally on the whole pattern. The locations of the droplets are determined via a Green's function of the domain. In constructing the droplet pattern we overcome three obstacles: interface oscillation, droplet coarsening, and droplet translation.

Turing Instability and Hopf Bifurcation: Spatio-temporal Dynamics

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Abstract: In this talk, we will first introduce the spatial dynamics in some reaction-diffusion systems induced by Turing instability. For reaction-diffusion equations with delay, the joint effects of diffusion and delay will be discussed. In particular, for two-dimensional systems where only the interaction between species is delayed, the interdependence of stability against delay and against diffusion can be clearly exhibited. Turing instability occurs largely independent of delay, while Hopf bifurcation can occur via increasing the delay or changing the diffusion rates. Examples with spatio-temporal dynamical behavior induced by the degenerated Turing-Hopf bifurcation will be demonstrated.

Linear stability of symplectic methods for Hamiltonian systems

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Abstract: Stability analysis is important in the computation of dynamics governed by a system of ordinary differential equations. Linear stability is the first step which relates to the local structures of trajectories near equilibria of the system and was studied extensively during past fifty years. For Hamiltonian systems, it is still a challenging problem to choose a "good" numerical method to mimic typical dynamics of typical systems. The linear stability has its own new aspects for the symplectic methods of Hamiltonian systems. In this talk we will present some results which are new and significant.

Speeds of Spread and Propagation for KPP Models in Time almost and Space Periodic Media

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Abstract: In this talk, I will first introduce a notion of spreading speed interval in any given direction for a time almost periodic and space periodic KPP model, which is a natural extension of the concept of the spreading speed for time independent or periodic KPP models and can be applied to more general time dependent KPP models. I will then present some recent results on the spreading speeds for the KPP models in time almost periodic and space periodic media, including upper and lower bounds and linear determinacy of the spreading speeds and the influence of time and space variation on the spreading speeds. This talk is based on a joint work with Jianhua Huang.

Extensions of bifurcation from simple eigenvalue theorem

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Abstract: Nonlinear equations can often be formulated as a nonlinear operator equation in Banach spaces, and the linearized operators are often linear Fredholm operators of index zero. Examples include a large class of quasilinear elliptic systems with nonlinear boundary conditions. A classical theorem of Crandall and Rabinowitz states that a bifurcation occurs at a simple eigenvalue along a branch of trivial solutions, and near the bifurcation point, the solution set consists of a line segment and a curve crossing it. We show a bifurcation theorem generalizing the classical one without *a priori* knowledge of a line of trivial solutions, which can also be used in perturbation problem of degenerate solutions. In another extension we show that the bifurcation from a simple eigenvalue is indeed global, which is also an extension of Rabinowitz's global bifurcation theorem which requires compactness. The talk is based on joint work with Ping Liu, Yuwen Wang of Harbin Normal University, and Xuefeng Wang of Tulane University.

Ensemble models of bifurcation phenomenon in cortical synapses

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Abstract: Individual cortical synapses are known to exhibit a very complex short-time dynamic behaviour in response to simple "naturalistic" stimulation. Nonetheless, physiological models of synapses are unable to explain the observed behaviour. We describe a computational study of the experimentally obtained excitatory post-synaptic potential trains of individual cortical synapses. By adopting a new nonlinear modelling algorithm we construct robust and repeatable models of the underlying dynamics. These models imply that cortical synapses respond with a wide range of periodic or chaotic dynamics. In particular, for stimulus at a fixed rate, a single bifurcation parameter, our models predict that the response of the individual synapse will vary from a fixed point to periodic and chaotic, depending on the frequency of stimulus. Extending our method to a two dimensional bifurcation parameter space we observe a rich and characteristic dependence of synaptic response on the preceeding stimuli. Dynamics for individual synapses vary widely, suggesting that

the individual behaviour of synapses is highly tuned and that the dynamic behaviour of even a small network of synapse-coupled neurons can be highly varied.

A Spatial Dynamics Approach to Water-Wave Problems

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Abstract: The talk concerns recent development on three-dimensional gravity-capillary water-wave problems as a spatial dynamical system. The water flow is assumed to be irrotational and bounded above by a free surface and below by a horizontal rigid bottom. The surface wave is propagating with a constant speed in one of the horizontal direction and periodic in the transversal direction. First, the problem is formulated as a dynamical system with the spatial variable in the propagation direction as the time variable and the nontrivial surface waves can then be obtained as bifurcations from the uniform state. By using center-manifold technique and normal form analysis together with the reversibility of the problem, the existence of three-dimensional waves which decay to periodic waves of small amplitude at infinity, called generalized solitary waves, in the propagation direction is obtained for the case when there are two pairs of 'two-dimensional' eigenvalues on the imaginary axis for the corresponding linear operator (the center manifold is eight dimensional). (This is a joint work with S. Deng)

Bifurcation of an asset pricing model with asymmetric beliefs

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Abstract: An asset pricing model with asymmetric beliefs is built. Based on the calculation of the coefficients of unique normal forms corresponding to different bifurcation types, the existence of generalized flip, generalized Neimark-Sacker,1:q-resonances, flip-Neimark Sacker bifurcations is proven. The results show that the excessive asymmetric action of chartists to good news and bad news and the too big amplitude of price adjustment of market maker can result into the excess volatility of asset prices. Then by using the numerical method, the phenomena of volatility clustering, fat tail are tested.

Enhanced modeling of the glucose-insulin system and its applications in insulin therapies

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Abstract: Several mathematical models have been proposed to model the glucose-insulin system and these models assume that insulin degradation is proportional to insulin production. In this talk, we will introduce a new model for the glucose-insulin regulatory system by revisiting insulin degradation. We will provide mathematical analysis of the new model. Some applications in insulin therapies will be discussed. Numerical simulations show that the proposed model is more realistic.

Oscillations in piecewise-linear switching networks with delay

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Abstract: In this talk, piecewise-linear switching networks(known as Glass networks) with a discrete delay are introduced and analyzed. The focus of this work is on cyclic patterns of switching. Under a condition that ensures an unambiguous pattern of switching, it is shown by means of a fractional linear mapping that delayed Glass networks have a periodic orbit for all positive finite delays. Furthermore, an algorithm is presented to locate the periodic orbit for a given cycle, to determine whether the periodic orbit is locally asymptotically stable, and to check if it is unique. This is joint work with R. Edwards and P. van den Driessche.

Wavelet Application in Statistical Analysis of Dynamical Data

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Abstract: Classification using dynamical data is a relatively new problem. We propose classification models for binary and multi-category data where the predictor is a random dynamical function. The technique is particularly useful for modeling nonlinear functions characterized by sharp local changes. We use Bayesian modeling with wavelet basis functions which have nice approximation properties over a large class of functional spaces and can accommodate a variety of functional forms observed in real life applications.

Using Dirichlet eigenvalues to measure effectiveness of thermal insulation

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Abstract: Of concern is the thermal insulation property of an anisotropic material (anisotropy means the thermal conductivity tensor is not a scalar). We propose to use the Dirichlet eigenvalues and eigenmodes, especially the principal ones, to measure the thermal insulation. More specifically, we propose to use the principal Dirichlet eigenvalue of the elliptic operator on the unit ball (occupied by the anisotropic material) as a simple thermal insulation measurement ; we obtain numerically user-friendly formulas for this Dirichlet eigenvalue in terms of the invariants of the thermal tensor. We also study the scenarios of protecting a space shuttle from overheating by coating it with an insulator. We establish and prove an easy-to-use rule for the optimal thickness of the coating. This talk is based on joint works with Steve Rosencrans, Bill Winter and Shan Zhao.

Kernel sections and uniform attractors of multi-valued semiprocesses

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Abstract: We present the existence of kernel sections (which are all compact, invariant and pullback attracting) of an infinite dimensional general multi-valued process constructed by the set-valued backward extension of multi-valued semiprocesses. Moreover, the structure of the uniform attractors of a family of multi-valued semiprocesses and the uniform forward attraction of kernel sections of a family of general multi-valued processes are investigated. Finally, we explain our abstract results by considering the mixed hyperbolic systems and ordinary differential equations.

Group Actions on Order-Preserving Skew-Product Semiflows with Applications

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Abstract: This talk is mainly concerned with the asymptotic symmetry of the order-preserving (OP) skew-product semiflows Π under a G-group action. It is shown that, for any stable minimal set K, there exists a residual set Y_0 of the base such that the fibres of Y_0 restricted to K are symmetric w.r.t. G, provided that Π is strongly order-preserving (SOP) and G is compact. In particular, any uniformly stable orbit is asymptotically symmetric. We further investigate the cases that Π is OP but no SOP, and G is not compact. The abstract results are then applied to the (asymptotic) symmetry of the stable solutions of nonautonomous parabolic equations on bounded or unbounded domain.

On p-adic dynamical systems

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Abstract: We shall talk about dynamical systems on the p-adic fields. We shall compare these systems with dynamical systems on the complex manifolds and discuss recent results and some unsolved problems.

The Minimal Molecular Surface

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Abstract: We introduce a novel concept, the minimal molecular surface (MMS), as a new paradigm for the theoretical modeling of biomolecule-solvent interfaces. When a less polar macromolecule is immersed in a polar environment, the surface free energy minimization occurs naturally to stabilizes the system, and leads to an MMS separating the macromolecule from the solvent. For a given set of atomic constraints (as obstacles), the MMS is defined as one whose mean curvature vanishes away from the obstacles. An iterative procedure is proposed to compute the MMS. Extensive examples are given to validate the proposed algorithm and illustrate the new concept. We show that the MMS provides an indication to DNA-binding specificity. The proposed algorithm represents a major step forward in minimal surface generation.

Hopf Bifurcation for Neutral Functional Differential Equations

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Abstract: In this paper, we extend the computation of the properties of Hopf bifurcation, such as the direction of bifurcation and stability of bifurcating periodic solutions, of DDE introduced by Kazarinoff et al[J.Inst.Math.Appl,21(1978)461-477] to a kind of neutral functional differential equations(NFDE). As an example, a neutral delay logistic differential equation is considered, and the explicit formulas for determining the direction of bifurcation and the stability of bifurcating periodic solutions are derived. Finally, some numerical simulations are carried out to support the analytic results.

An Analytical Method for the Linearization of Dynamic Equation on Measure Chains

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Abstract: In this paper, by introducing the concept of topological equivalence on measure chain, we investigate the relationship between the linear system $x^{\Delta} = A(t)x$ and the nonlinear system $x^{\Delta} = A(t)x + f(t,x)$. Some sufficient conditions are obtained to guarantee the existence of a equivalent function $H(t,x)$ sending the (c,d)-quasibounded solutions of nonlinear system $x^{\Delta} = A(t)x + f(t,x)$ onto those of linear system $x^{\Delta} = A(t)x$. Our results generalize the Palmer's linearization theorem in [Palmer, *J. Math. Anal. Appl.*, **41**(1973),753-758.] to dynamic equation measure chains. In the present paper, we give a new analytical method to study the topological equivalence problem on measure chains. As we will see, due to the completely different method to investigate the topological equivalence problem, we have a considerably different result from that in the pioneering work of [Hilger, *J. Austral. Math. Soc. Ser. A*, **60** 2 (1996),157-191.]. Moreover, we prove that equivalent function $H(t,x)$ is also ω-periodic when the systems are ω-periodic. Hilger never considered this important property of the equivalent function $H(t,x)$.

Existence Theorems for Periodic Markov Process and Ito Stochastic Functional Differential Equations

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Abstract: In this paper, we give existence theorems for periodic Markov process and Ito stochastic functional differential equations, which are stochastic versions of the Hale theorem on periodic process and the Wintner theorem on ordinary differential equations.

On sensitivity

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Abstract: In this talk we will discuss sensitivity both in topological dynamics and measure-theoretical dynamics.

On the critical periods of perturbed isochronous centers

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Abstract: Consider a family of planar systems $\dot{x} = X(x, \varepsilon)$ having a center at the origin and assume that for $\varepsilon = 0$ they have an isochronous center. Firstly, we give an explicit formula for the first order term in ϵ of the derivative of the period function. We apply this formula to prove that, up to first order in ϵ, at most one critical period bifurcates from the periodic orbits of isochronous quadratic systems when we perturb them inside the class of quadratic reversible centers. Moreover necessary and sufficient condition for the existence of this critical period are explicitly given. From the tools developed in this paper we also provide a new characterization of planar isochronous centers. This is a joint work with Prof. Gasull Armengol, Department de Matemotiques Universitat Autonoma de Bacelona.

Subharmonic solutions of prescribed minimal period for discrete Hamiltonian systems

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Computation of Focus Values with Applications

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Abstract: Computation of focus (or focal) values for nonlinear dynamical systems is not only important in theoretical study, but also useful in applications. In this talk, we compare three typical methods for computing focus values, and give a comparison among these methods. Then, we apply these methods to study two practical problems and Hilbert's 16th

problem. We show that these different methods have the same computational complexity. Finally, we discuss the "minimal singular point value" problem.

Singularity Analysis on a Planar System with Multiple Delays

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Abstract: A planar model with multiple delays is studied. The singularities of the model and the corresponding bifurcations are investigated by using the standard dynamical results, center manifold theory and normal form method of retarded functional differential equations. It is shown that Bogdanov-Takens (BT) singularity for any time delays, and a series of pitchfork and Hopf bifurcation can coexistent. The universal unfoldings of the normal forms at the Bogdanov-Takens singularity and the singularity of a pure imaginary and a zero eigenvalue are given respectively. Numerical simulations have been provided to illustrate the theoretical predictions.

Traveling Pulses for the nonlocal and lattice Klein-Gordon Equation

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Abstract: We study traveling pulses on a lattice and in a continuum where all pairs of particles interact, contributing to the potential energy. The interaction may be positive or negative, depending on the particular pair but overall is positive in a certain sense. For such an interaction kernel J with unit integral (or sum), the operator $\frac{1}{\varepsilon^2}[J * u - u]$, with $*$ continuous or discrete convolution, shares some common features with the spatial second derivative operator, especially when ε is small. Therefore, the equation $u_{tt} - \frac{1}{\varepsilon^2}[J * u - u] + f(u) = 0$ may be compared with the nonlinear Klein-Gordon equation $u_{tt} - u_{xx} + f(u) = 0$. If f is such that the Klein-Gordon equation has supersonic traveling pulses, we show that the same is true for the nonlocal version, both the continuum and lattice cases.

Continuity in Weak Topology

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Abstract: Given a potential $q(t) \in L^1(R/2\pi Z)$. The Hill's equation

$$x'' + q(t)x = 0$$

represents oscillation of a string. Via solutions of Hill's equations, the potential $q(t)$ defines many important quantities in analysis and dynamical systems such as eigenvalues (with different kinds of boundary conditions) and rotation number, Floquet multipliers and Lyapunov exponents, etc. It is well-known that these quantities are all continuous in potentials $q(t)$ in the usual L^1 topology, and some of them, such as eigenvalues are continuously differentiable in $q(t)$ in the L^1 topology.

In this paper, I will point out that theses quantities are all continuous in $q(t)$ in the topology of weak convergence of the space $L^1(R/2\pi Z)$. Such a strong continuity will result in many interesting problems in estimations of eigenvalues and other quantities in dynamical systems.

Many Pulses Homoclinic Orbits with a Melnikov Method and Chaotic Dynamics for Nonlinear Nonplanar Motion of a Cantilever Beam

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Abstract: The many pulses homoclinic orbits with a Melnikov method and chaotic dynamics for the nonlinear nonplanar oscillations of a cantilever beam are studied in this paper for the first time. The cantilever beam studied here is subjected to a harmonic axial excitation and two transverse excitations at the free end. The nonlinear governing equations of nonplanar motion with parametric and external excitations are obtained. The Galerkin procedure is applied to the partial differential governing equations to obtain a two-degree-of-freedom nonlinear system under combined parametric and forcing excitations. The resonant

case considered here is principal parametric resonance-1/2 subharmonic resonance for the first mode and fundamental parametric resonance-primary resonance for the second mode. The parametrically and externally excited system is transformed to the averaged equation by using the method of multiple scales. From the averaged equation, the theory of normal form is used to find the explicit formulas of normal form. Based on normal form obtained above, an extension of the Melnikov method is utilized to analyze the multi-pulse global bifurcations and chaotic dynamics for the nonlinear nonplanar oscillations of the cantilever beam. The analysis of global dynamics indicates that there exist the multi-pulse jumping orbits in the perturbed phase space of the averaged equation for the nonlinear nonplanar oscillations of the cantilever beam. These results show that the multi-pulse homoclinic orbits chaotic motions can occur for the nonlinear nonplanar oscillations of the cantilever beam. Numerical simulations are given to verify the analytical predictions. It is also found from the results of numerical simulation in three-dimensional phase space that the multi-pulse orbits exist for the nonlinear nonplanar oscillations of the cantilever beam. In addition, the experiments are carried out to investigate the periodic and chaotic behaviors of the nonplanar vibrations in a cantilever beam subjected to harmonic vertical base excitation. The nonlinear vibrations of the cantilever beam are measured and analyzed using the waveform, phase portrait and Fourier spectrum technique. Sweeping the frequency and amplitude of the excitation, we respectively obtained the period-1, period-2 and chaotic motion. From the experimental results, we also find clearly the multi-pulse motions of the cantilever beam in three dimensional phase portraits. The study also provides quantitative experimental evidence to indicate complex dynamic phenomena in the nonlinear nonplanar oscillations of a cantilever beam.

Jarque and Villadelprat's Open Problem on Non-isochronicity

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Abstract: In 2002 X. Jarque and J. Villadelprat proved that no center in a planar polynomial Hamiltonian system of degree 4 is isochronous and raised an open problem: Is there a planar polynomial Hamiltonian system of even degree which has an isochronous center? In this talk this problem is solved partly.

Integrable Hamiltonian Systems and topological entropy

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Abstract: In this talk we will introduce the integrable Hamiltonian systems on Riemannian manifold, and the topology of the integrable systems. Especially, we give the characterization of the orthogonally separable Hamiltonian systems with the configuration space a three dimensional quotient manifold induced by the Anosov map. Moreover, we prove that the Hamiltonian flow on the regular level energy surface has a positive topological entropy. As a result, we obtain the first example, as our knowledge, of C^∞ Liouvillian integrable Hamiltonian flows with a potential energy on a Riemannian manifold which has a positive topological entropy.

Analysis of a SIS epidemic model with control

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Abstract: From the classical SIS epidemic, we obtain a group of discrete dynamic models which are taken on the same form. We then investigate one of these models. For this discrete model, the invariant set is an interval $[0, 1]$. There are two parameters $\alpha, \theta \in (0, 1)$ to which the dynamical behavior is sensitive. We focus on asymptotic behavior as α and θ change. In particular, α is more sensitive than θ in terms of appearance of half-period bifurcation. It shows that it occurs a stable half-period bifurcation appears or only a stable fixed point. Zero is always an unstable fixed point. As an application, we do numerical simulation for influenza using a set of known data.

Existence of Multiple Positive Solutions for m-point Boundary Value Problems in Banach Spaces

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Abstract: In last thirty years, the theory of ordinary differential equations in Banach space has become a new important branch. On the other hand, the multi-point boundary value problems arising from applied mathematical and physical have been received a great deal of attention in the literature. However, to the author's knowledge, few papers can be found in the literature for multi-point boundary value problems in Banach space. In this paper, we shall discuss the existence of positive solutions to the following m-point boundary value problem:

$$u''(t) + a(t)f(t, u(t)) = \theta, \quad 0 < t < 1,$$
$$u'(0) = \sum_{i=1}^{m-2} b_i u'(\xi_i), \quad u'(1) = \sum_{i=1}^{m-2} a_i u(\xi_i),$$

in Banach spaces E, where θ is zero element of E, $\xi_i \in (0, 1)$ with $0 < \xi_1 < \xi_2 < \cdots < \xi_{m-2} < 1$, and $a_i, b_i \in [0, \infty)$, $(i = 1, 2 \cdots, m-2)$. By using the fixed-point theorem of strict-set-contractions, some sufficient conditions for the existence of at least one or two positive solutions to m-point boundary value problem in Banach spaces are obtained. An example illustrating the main results is given. And our result extends and complements some known results.

Global Asymptotic Stability of Minimal Fronts in Monostable Lattice Equations

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Abstract: In this talk, I will report on our recent research results on the global asymptotic stability with phase shift of traveling wave fronts of minimal speed, in short minimal fronts, for a large class of monostable lattice equations and reaction-diffusion equations. Our approach is via the method of upper and lower solutions and a squeezing technique. I will also discuss some open problems. This talk is based on the joint work with Shiwang Ma.

Finite dimensionality and upper semi-continuity of compact kernel sections of non-autonomous lattice systems

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Abstract: We first present a set of sufficient and necessary conditions for the existence of globally attractive kernel sections for processes defined on a general Banach space and a weighted space ℓ^p_ρ of infinite sequences ($p \geq 1$), respectively. Then we establish a criteria for finite fractal dimensionality of a family of compact subsets of a Hilbert space, and apply it to obtain an upper bound of fractal dimension of compact kernel sections to first order non-autonomous lattice reaction-diffusion systems. Finally we consider the upper semi-continuity of kernel sections of general first order non-autonomous lattice systems.

Codimension 3 Double Homoclinic Loops Bifurcations with Resonant Eigenvalues

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Abstract: This paper presents the double-homoclinic-loop bifurcations with resonant eigenvalues in four dimensional vector fields. The Poincarè map is established to solve various problems in double-homoclinic-loop bifurcations with codimension 3. Bifurcation diagrams and bifurcation curves are given.

Oscillations in Predator-Prey Competition Models

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Abstract: Predator-prey type of systems are important models in mathematical ecology and epidemiology. In this talk, I shall first talk about the possible bifurcations which lead to the oscillations of the predator-prey systems. The bifurcations include Hopf and homoclinic bifurcations and Bogdanov-Takens bifurcations of lower codimensions. Then the periodic perturbations of such systems will be explored both analytically and numerically.

Existence and global attractivity of positive periodic solution in Lotka-Volterra competition systems with deviating arguments

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Abstract: In this talk, we consider the periodic Lotka-Volterra competition systems with deviating arguments. We present some sufficient conditions, and sufficient and necessary conditions for a special case, for existence of a positive periodic solution. We also establish some 3/2 type criteria for the global attractivity of the positive periodic solution. This talk is based on a work with Xianhua Tang and a work with Daoming Cao and Xianhua Tang.

SD oscillator: the attractors and the complex dynamics

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Abstract: We provide a new oscillator to investigate transitions from smooth to discontinuous dynamics by investigating the an archetype model. The dynamics of this oscillator

depend on the value of a smooth parameter α. The oscillator behaves a smooth dynamics for $\alpha > 0$, written as

$$x'' + x(1 - \frac{1}{\sqrt{x^2 + \alpha^2}}) = 0, \tag{3}$$

while $\alpha = 0$, system (3) becomes discontinuous dynamics, written as

$$x'' + (x - \text{sign}(x)) = 0. \tag{4}$$

This typical system is called SD oscillator, see [Cao Q., Wiercigroch M. , Pavlovskaia E. E., Grebogi C. and J.M.T. Thompson, Phys. Rev. E 74, 046218 (2006)]. In the smooth regime, the system bears significant similarities to the Duffing oscillator, exhibiting the standard dynamics governed by the hyperbolic structure associated with the stationary state of the double-well. At the discontinuous limit, however, there is a substantial departure in the dynamics from the standard one. We call the equilibrium $(0, 0)$ the saddle-like singular. The special orbit composed of this point together with the separatrix is called the homoclinic like orbit. The attractors of the system in the presence of damping and external excitation are called SD attractors. Examples are given for the smooth and the discontinuous regime.