Abstract

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

1.

Kinesin-Microtubule Interactions: Transport and Spindle Formation

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Abstract: This talk consists of two parts: Pattern formation in families of microtubules under the action of kinesin and the detailed motion of kinesin along a microtubule.

Microtubules are long cylindrical structures (lengths being tens of microns and diameter approximately 25 nm) comprised of tubulin dimers, which self-assemble, 13 protofilaments being required side-to-side to form the circular cross section. In the first set of results, microtubules are represented as stiff, polar rods which are subject to diffusion in position and orientation and also subject to pair-wise interaction, mediated by kinesin molecular motors. The concentration of kinesin is represented by a parameter that feeds into the probability of an interaction occurring when two microtubules collide. The probability of an interaction also depends on the location of the collision point along the lengths of the microtubules, because kinesin accumulates at the positive end of each microtubule. With collision rules in place, Monte-Carlo simulations for large numbers of freely moving microtubules are performed, adjusting parameters for concentration of kinesin and polarity of the microtubules. From these studies, a phase diagram is produced, indicating thresholds for phase change to occur. Simulation results are compared to those from in vitro experiments.

The second part of the talk involves modeling the fine scale dynamics of a kinesin motor as it walks along a microtubule. The two heads of the kinesin molecule alternately bind and unbind to the microtubule with certain mechanisms providing a directional bias to the Brownian motion expected. One bias is the shape of the head and the shape of the binding site, along with the companion electrostatic charges. The second bias is that, utilizing ATP capture and transferal of phosphors for energy, part of the polymeric leg (neck-linker) of the bound head becomes attached towards the front of that head (the "zipped" state). The trailing head detaches from the microtubule. It then becomes subject to the biased entropic force due to the zipped state of the leading head and also preferentially (because of shape orientation) attaches in front of the currently attached head at which time ADP is released and a conformational change occurs, strengthening the binding. This motion is modeled using stochastic a differential equation. Simulations are performed with different lengths of neck-linkers and the mean speeds of progression obtained. These are compared with experimental results.

2.

Bursting phenomena in nonlinear systems with multiple time scales

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Abstract: Multiple time scales may come not only from the real fast-slow effect in real time domain, but also from the scale effect of the structure combinations. This talk focuses on the nonlinear behaviors with two time scales. Dynamical evolution of several typical oscillators have been discussed in details, which shows that different types of bursting phenomena can be observed. For each type of burster, two kinds of bifurcation forms exist, which leads the trajectories alternate between quiescent state and spikes. The analysis for both the autonomous and periodically excited systems reveals that the bifurcation forms determine the behavoir of the whole systems. Furthermore, for the non-smooth oscillators, non-conventional bifurcation which is a combination of several bifurcation forms occurring at the switch boundaries may lead the behaviors alternate between quiescent state and spikes.

3.

Cooperative behaviors of bursts in map-based neuron networks

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Abstract: In this talk, first of all, a system consisting of two identical Rulkov map-based neurons coupled by reciprocal electrical and chemical synapses with the fast threshold modulation is introduced. Second, different patterns of bursting and synchronized behaviors of the system are discussed when some of sensitive parameters are taken into account by using the fast-slow decomposing technique, the phase plane analytical technique, bifurcation analyses, and the master stability functions. Finally these patterns and behaviors found in the two-neuron system are numerically extended to relatively larger networks under different topological structures.

4.

Nonlinear Dynamics of an Archetype Rig-Coupled SD Oscillator

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Abstract: SD oscillator is the recently proposed archetype nonlinear system, details seen in [1], which depends on a smooth parameter exhibiting both smooth and discontinuous or

standard and nonstandard dynamics of double well potential. The dimensionless equation of motion can be written in the form,

$$\ddot{x} + x\left(1 - \frac{1}{\sqrt{x^2+\alpha^2}}\right) = 0. \tag{1}$$

It can be seen that the parameter α plays an important role in dominating the behaviour of the system. The system is smooth if $\alpha > 0$, while this system is discontinuous when $\alpha = 0$. Usually, system (1) is named as the SD Oscillator (here S indicates smooth and D stands for discontinuous) and the attractors of the perturbed system are named as the SD oscillators [2, 3].

Here we present an archetype rig-coupled SD oscillator, the dimensionless equation of motion is given by,

$$\ddot{x} + (x-\beta)\left(1 - \frac{1}{\sqrt{(x-\beta)^2+\alpha^2}}\right) + (x+\beta)\left(1 - \frac{1}{\sqrt{(x+\beta)^2+\alpha^2}}\right) = 0, \tag{2}$$

the dynamics of which depends on two systematic parameters, α and β. This system is just the original SD oscillator if $\beta = 0$ and it is smooth when $\alpha \neq 0, \beta \neq 0$, while it is discontinuous for $\alpha = \beta = 0$.

We demonstrate that the unperturbed system, system (2), behaves standard dynamics of single well, double well and triple well potential if it is smooth with degenerate heteroclinic orbit, homoclinic orbit and the homo-heteroclinic orbit connecting the saddles. While it is discontinuous, it exhibits nonstandard dynamics of single well, double well and triple well potential with degenerate heteroclinic-like orbit, homoclinic-like orbit and the homo-heteroclinic-like orbit connecting the saddle-like singularities. We also show the complicated nonlinear dynamics of the perturbed system with periodic, quasi-periodic and strange attractors, the co-existence of the attractors and the basins of the co-existed attractors as well.

References

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[2] ———-, Piecewise linear approach to an archetypal oscillator for smooth and discontinuous dynamics, Phil. Trans. R. Soc. A **366** (2008) , 635–652.

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5.

Logic Computation Based on Dynamical Systems

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Abstract: As a paradigm for nonlinear spatial-temporal processing, cellular nonlinear networks (CNN) are biologically inspired dynamical systems where computation emerges from a collection of simple locally coupled nonlinear cells. Our investigation is an exploration of an important and difficult aspect of implementing logical functions (Boolean functions) by using CNN. In this paper, we focus on establishing a complete set of mathematical theories for the Boolean functions. Two criteria for linearly separable Boolean function (LSBF) and parity Boolean function (PBF) are proposed, respectively, and a novel learning algorithm named DNA-like learning is developed, which is able to quickly train a network with any prescribed logical functions. Moreover, a new concept named CNN universal perceptron (CNN-UP) is developed, which may lead to a PC software in designing CNN and perceptron in artificial neural networks (ANN).

6.

Heteroclinic Tangles In Time-Periodic Equations

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Abstract: This paper is a study on periodically perturbed second order equations with dissipation. We prove that, when a heteroclinic loop is periodically perturbed, three types of heteroclinic tangles are created and they compete in the space of u where u is a parameter representing the magnitude of the perturbations. The three types are (a) transient heteroclinic tangles containing no Gibbs measures; (b) heteroclinic tangles dominated by sinks representing stable dynamical behavior; and (c) heteroclinic tangles with strange attractors admitting SRB measures representing chaos. We also prove that, as u0, the organization of the three types of heteroclinic tangles depends sensitively on the ratio of the unstable eigenvalues of the saddle fixed points of the heteroclinic connections. The theory developed in this paper is explicitly applicable to the analysis of a given set of differential equations and the results obtained are well beyond the capacity of the classical Birkhoff-Melnikov-Smale method. A comprehensive analysis of a given example and a systematic numerical exploration guided by the theory are also presented at the end.

7.

Structure of Principal Eigenvectors and Genetic Diversity

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Abstract: The main concern of this paper is the models for genotype diversity. Genotypes are represented as finite sequences $(s_1, s_2, \ldots, s_n)$, where the entries $\{s_i\}$ are drawn from a finite alphabet. The mutation matrix is given in terms of Hamming distances. It is proved that the long time behavior of a class of genotype evolution models is governed by the principal eigenvectors of sum of mutation and fitness matrices. It is proved that the components of principal eigenvectors are symmetric and monotonically decreasing in terms of Hamming distances.

8.

Homoclinic solutions for a class of subquadratic second-order Hamiltonian systems

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Abstract: In this talk, we consider the existence of infinitely many homoclinic solutions for a class of subquadratic second-order Hamiltonian systems. By using the variant fountain theorem, we obtain a new criterion for guaranteeing that second-order Hamiltonian systems has infinitely many homoclinic solutions. Recent results are generalized and significantly improved. An example is also given to illustrate our main results.

9.

Threshold dynamics of delayed reaction-diffusion equations in unbounded domains

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Abstract: In this talk, we study a nonlocal delayed reaction-diffusion equation in an unbounded domain arising from population dynamics. To overcome the difficulty in describing the global dynamics due to the lack of non-compactness of the solution semiflow, we establish some *a priori* estimates, with respect to the compact open topology of the natural phase space, for the nonlocal delayed nonlinearity and the diffusion operator. This enables us to obtain the existence of a bounded and positively invariant set Y in $C_+ = C([-1,0], X_+)$ that attracts every solution of the equation, where X_+ is the set of all bounded and continuous functions from R to $[0,\infty)$, and on which the solutions induce a compact and continuous semiflow Φ. We then describe the delicate asymptotic behaviors of Φ in the neighborhood of the trivial equilibrium and show when nontrivial solutions are expelled away from a given neighborhood of the trivial equilibrium, and then employ standard dynamical system theoretical arguments to establish the global threshold dynamics. We illustrate our main results with the generalized nonlocal delayed reaction-diffusion Nicholson blowfly equation and the diffusive Mackey-Glass equation. This is a joint work with Taishan Yi and Jianhong Wu.

10.

Fokker-Planck Equations for a Free Energy Functional or Markov Process on a graph, part I

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Abstract: Fokker-Planck equation is a linear parabolic equation which describes the time evolution of probability distribution of a stochastic process defined on a Euclidean space. Corresponding to the stochastic process, there often is a free energy functional which is defined on the space of probability distributions and is a linear combination of a potential and an entropy. In recent years, it has been shown that Fokker-Planck equation is the gradient flow of the free energy functional defined on the Riemannian manifold of probability distributions whose inner product is generated by a Wasserstein distance. In this talk, we will consider similar matters for a free energy functional or Markov process defined on a graph with a finite number of vertices and edges. If N is the number of vertices of the graph, then we will show that the corresponding Fokker-Planck equation is a system of N nonlinear ordinary differential equations defined on a Riemannian manifold of probability distributions. However, in contrast to the case of stochastic processes defined on Euclidean spaces, we have different choices for inner products for the set of probability distributions resulting in different Fokker-Planck equations for the same process with different random perturbations. It is shown that there is a strong connection but also substantial differences between the ordinary differential equations and the usual Fokker-Planck equation on Euclidean spaces. Furthermore, each of these ordinary differential equations is a gradient flow for the free energy functional defined on a Riemannian manifold whose metric is closely related to certain Wasserstein metrics. Some examples will also be discussed. The 2nd part of the talk is by Prof. Wen Huang.

11.

Multiple solutions for a class of impulsive differential equations with Dirichlet boundary conditions via critical point theory

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Abstract: In this paper, a class of impulsive differential equations with Dirichlet boundary conditions are considered. Multiplicity results are obtained by critical point theory. Our approach is novel and it opens a new approach to deal with the nonlinear problems with some type of discontinuities such as impulsive ones. Recent results in the literature are generalized and significantly improved.

12.

Existence and Global Attractivity of Positive Periodic Solution to a Lotka-Volterra Model

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Abstract: In this paper, we study the existence of positive periodic solution to a Lotka-Volterra model with mutual interference and Holling III type functional response as follows

$$\begin{cases} \dot{x} = x(t)(r_1(t) - b_1(t)x(t)) - \frac{c_1(t)x^2(t)}{x^2(t)+k^2} y^m(t), \\ \dot{y} = y(t)(-r_2(t) - b_2(t)y(t)) + \frac{c_2(t)x^2(t)}{x^2(t)+k^2} y^m(t). \end{cases}$$

By using Mawhin's continuation theorem and constructing suitable Lyapunov functional, some sufficient conditions are obtained for the existence, uniqueness and global attractivity of positive periodic solution of the model. Furthermore, the conditions are related to the interference constant m.

13.

What is the Impact of Noise on Invariant Manifolds?

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Abstract: Invariant manifolds are essential geometric tools for understanding deterministic dynamical systems. For stochastic dynamical systems, however, invariant manifolds are quite delicate objects. Random invariant manifolds are sample-dependent geometric objects, but they are not easy to be geometrically visualized or numerically computed.

To better understand random invariant manifolds and thus utilize them as building blocks to decode stochastic dynamics, we present a method for approximating random invariant manifolds when noise is small. This method provides a tool for quantifying the impact of small noise on invariant manifolds, and thus shed lights on describing stochastic dynamics.

14.

Bifurcation Diagrams of Coupled Schrodinger Systems

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Abstract: Radially symmetric solutions of many important systems of partial differential equations can be reduced to systems of special ordinary differential equations. We develop a numerical solver for initial value problems for such systems based on Matlab, and we obtain numerical bifurcation diagrams. Various bifurcation diagrams of coupled Schrodinger equations from nonlinear physics are obtained which suggests the uniqueness of the ground state solutions.

15.

Exponential Dichotomies of Linear Dynamic Equations

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Abstract: In this paper, we define the exponential dichotomy of linear dynamic equations on time scales, then we present perturbation theorems on the roughness of exponential dichotomy, and develop several explicit sufficient criteria, necessary and sufficient criteria for linear dynamic equations to have an exponential dichotomy. As applications of the criteria of exponential dichotomy, we derive some new sufficient conditions for the existence of periodic solutions of semi-linear dynamic equations and nonlinear dynamic equations on time scales.

16.

Exploring Brain Networks by Using Network Science

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Abstract: Network science is one of interdisciplinary science and provides a new idea and method to study complex system and complexity science. The brain is the most mystery complex system. Exploring the brain networks has became an advancing front science by using network science. This article will review how to apply the theory method of network science to explore the brain's mystery, and outlines the main progresses at home and abroad. The significance of small-world and scale-free properties as well as modularity of the brain network is explained for biology. Some thinking and challenging problems are pointed out finally.

17.

Duffing-van der Pol Oscillator and Applications to Degenerate Reaction-Diffusion Systems

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Abstract: In this talk, we are concerned with a Duffing-van der Pol Oscillator system, and a degenerate reaction-diffusion system where some species migrate from densely populated areas into sparsely populated areas to avoid crowding, and investigate a more general reaction-diffusion system by considering density-dependent dispersion as a regulatory mechanism of the cyclic changes. Here the probability that an animal moves from the point x1 to x2 depends on the density at x1. Under certain conditions, we apply the higher terms in the Taylor series and the center manifold method to obtain the local behavior around a non-hyperbolic point of codimension one in the phase plane for the reaction-diffusion system. Then, we use the Lie symmetry reduction method to explore bounded traveling wave solutions in the functional forms. Finally, a remarking conclusion is given on the existing results.

18.

On Global Attractors for Some Singular Nonhyperbolic Systems

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Abstract: This talk discusses dynamical behaviors of a class of nonhyperbolic systems arising from signal processing, digital filters and modulator dynamics. Planar piecewise isometries may be discontinuous and/or non-invertible. First, attraction caused by singularity in planar piecewise isometries is considered. Namely, it is shown that the maximal invariant set can induce an invariant measure, and all the Lyapunov exponents are zero under this invariant measure. Second, various definitions of global attractors and their existence and uniqueness for maps with singularities are discussed, and a few examples in which the attractors are created due to discontinuity are introduced. Third, the relation between invariance and invertibility for various nonhyperbolic maps is studied, and finally decomposability of global attractors for certain singular nonhyperbolic systems is investigated.

19.

Multi-Valued Characteristics, Morse Decompositions and Periodic Orbits

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Abstract: The theory of monotone input-output systems has been successfully applied to models of complex biological and chemical interactions. We extend the theory to the situation when the open loop system has multiple stable equilibria and hence a multi-valued characteristic. We construct a Morse decomposition for a generic set of solutions of the closed loop system based on Morse decomposition of the open loop system. We show that the character of some Morse sets is determined by the single-valued branches of the input-output characteristic. In the second part of the talk we use the theory of multi-valued characteristics to that a monotone systems coupled to a slowly varying negative feedback admits a relaxation periodic orbit if a simple model system in R^2 does. Our construction can be used to prove the existence of periodic orbits in slow-fast systems of arbitrary dimension. If time permits, we will present an application to a model of a cell cycle in Xenopus embryos.

20.

On Hopf bifurcations of piecewise planar Hamiltonian systems

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Abstract: In this paper we study the number of limit cycles appearing in Hopf bifurcations of piecewise planar Hamiltonian systems of the form

$$\dot{x} = H_y,\ \dot{y} = -H_x,\ x \neq 0,$$

where

$$H(x,y) = \begin{cases} H^+(x,y), & x > 0, \\ H^-(x,y), & x < 0, \end{cases}$$

and $H^{\pm}(x,y) \in C^{\omega}$ with $H^{\pm}(0,0) = 0$. In our main results we obtain lower and upper bounds of the number of limit cycles near the origin respectively. For some systems of special form we obtain the Hopf cyclicity.

21.

Explicit Flow Equations and Recursion Operator of the ncKP hierarch

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Abstract: The explicit expression of flow equations of the noncommutative Kadomtsev-Petviashvili(ncKP) hierarchy is derived. By comparing with the flow equations of the KP hierarchy, this result shows that the additional terms in flow equations of the ncKP hierarchy indeed consist commutators of dynamical coordinates $\{u_i\}$. The recursion operator for the flow equations under the n-reduction is presented. As an example we calculate the recursion operator of the noncommutative Korteweg-de Vries(ncKdV) hierarchy, which generates a hierarchy of local, higher order flows. Thus we solve the open problem suggested by P.J. Olver and V.V. Sokolov(Commun.Math.Phys. 193 (1998), 245-268).

22.

A Model of Financial Market with Delay

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Abstract: Within a continuous-time framework, this talk will present a stochastic heterogeneous agent model (**HAM**) of financial markets with time delays to unify various moving average rules used in discrete-time **HAM**s. The time delay represents a memory length of a moving average rule in discrete-time **HAM**s. Intuitive conditions for the stability of the fundamental price of the deterministic model in terms of agents' behavior parameters and memory length are obtained. It is found that an increase in delay not only can destabilize the market price, result- ing in oscillatory market price characterized by a Hopf bifurcation, but also can stabilize an otherwise unstable market price, leading to stability switching as the memory length increases. Numerical simulations show that the stochastic model is able to characterize long deviations of the market price from its fundamental price and excess volatility and generate most of the stylized facts observed in financial markets.

23.

Experimental observation of chaotic phase synchronization of a periodically modulated multimode Nd:YVO_4 laser

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Abstract: We demonstrate the experimental observation of chaotic phase synchronization of a periodically modulated multimode Nd:YVO_4 laser. The chaotic phase synchronization strength is measured by means of the recurrence analysis, in which the relationship of time series between the laser output intensity and the periodically modulated signal were considered. The synchronization diagram of the pump current modulated with frequency and amplitude exhibit the Arnold tongue. Finally, the numerical analysis is in good agreement with the experimental results.

24.

Topological Characterization of a Coupled Ricker Patch Model

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Abstract: Ecologists use Ricker patch models to study meta population dynamics. Thresholding population values in this model results in spatial-temporal dispersal patterns. The focus of this work is to use the zero-th Betti number, which is the number of connected components, to measure dispersal patterns as a function of the local fitness parameter.

25.

Dynamics of Non-newtonian partial differential equations driven by fractional Brownian motions

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Abstract: n this talk, the existence and uniqueness of the mild solution of the non-Newtonian partial differential equations driven by fractional Brownian motions are firstly shown by the fixed point theorem,and stochastic inertial manifold exists for the random dynamical systems. Then,the strong Feller property and irreducibility are proved to get the existence and uniqueness of invariant measure, and the large derivation principle are also provided.

26.

Fokker-Planck Equations for a Free Energy Functional or Markov Process on a graph, Part II

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Abstract: Fokker-Planck equation is a linear parabolic equation which describes the time evolution of probability distribution of a stochastic process defined on a Euclidean space. Corresponding to the stochastic process, there often is a free energy functional which is defined on the space of probability distributions and is a linear combination of a potential and an entropy. In recent years, it has been shown that Fokker-Planck equation is the gradient flow of the free energy functional defined on the Riemannian manifold of probability distributions whose inner product is generated by a Wasserstein distance. In this talk, we will consider similar matters for a free energy functional or Markov process defined on a graph with a finite number of vertices and edges. If N is the number of vertices of the graph, then we will show that the corresponding Fokker-Planck equation is a system of N nonlinear ordinary differential equations defined on a Riemannian manifold of probability distributions. However, in contrast to the case of stochastic processes defined on Euclidean spaces, we have different

choices for inner products for the set of probability distributions resulting in different Fokker-Planck equations for the same process with different random perturbations. It is shown that there is a strong connection but also substantial differences between the ordinary differential equations and the usual Fokker-Planck equation on Euclidean spaces. Furthermore, each of these ordinary differential equations is a gradient flow for the free energy functional defined on a Riemannian manifold whose metric is closely related to certain Wasserstein metrics. Some examples will also be discussed. The 1st part is given by Prof. Shui-Nee Chow.

27.

Problem on Minimum Wave Speed of Traveling Waves for a Lotka-Volterra Competition Model

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Abstract: Consider a reaction-diffusion system that serves as a 2-species Lotka-Volterra competition model with each species having logistic growth in the absence of the other. Suppose that the corresponding reaction system has one unstable boundary equilibrium E_1 and one stable boundary equilibrium E_2. Then it is well known that there exists a positive number C_*, called the minimum wave speed, such that, for each c larger than or equal to C_*, the reaction-diffusion system has a positive traveling wave solution of wave speed c connecting E_1 and E_2, and the system has no nonnegative traveling wave with wave speed less than C_*. It has been shown that the minimum wave speed for this system is identical to another important quantity — the speed of the population spread towards to the stable equilibrium. Hence to find the minimum wave speed C_* not only is of the interest in mathematics but is of the importance in application. Although much research work has been done to give an estimate of C_* and some partial results have been obtained, the problem on finding an algebraic or analytic expression for the minimum wave speed remains unsolved in general. In this talk we will introduce a new, more efficient approach that enable us to determine precisely the minimum wave speed algebraically under conditions weaker than those given previously. We also show that the minimum wave speed in general cannot be determined by the linearization at the unstable equilibrium point. A conjecture on the minimum wave speed is also given.

28.

Response and Stability of SDOF Viscoelastic System Under Wide-band Noise Excitations

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Abstract: The response and stability of a single degree-of-freedom (SDOF) viscoelastic system with strongly nonlinear stiffness under the excitations of wide-band noise are studied in this paper. Firstly, terms associated with the viscoelasticity are approximately equivalent to damping and stiffness terms; the viscoelastic system is approximately transformed to SDOF system without viscoelasticity. Then, with the application of the method of stochastic averaging, the averaged differential equation is obtained. The stationary response and the largest Lyapunov exponent can be analytically expressed. The effects of different system parameters on the response and stability of the system are discussed as well.

29.

Reaction-Diffusion Equations for Two Species Competing for Two Complementary Resources with Internal Storage

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Abstract: This talk presents a systems of reaction-diffusion equations modelling for two species competing for two complementary resources with internal storage in an unstirred chemostat. The conservation principles are used to reduce the dimension of our system by eliminating the equations for the nutrients. The reduced limiting system generates a strongly monotone dynamical system in its feasible domain under a suitable partial order. This reduced system contains two invariant subsystems which are proved to have dichotomy dynamics. Given the parameters of the reduced system, we answer the basic questions as to which species survives and which does not in the spatial environment and determine the global behaviors. The sufficient conditions, via species's intrinsic biological characteristics, the external environment forces and the principal eigenvalues of some scalar partial differential equations are given to conclude that the extinction, competitive exclusion and persistence. The main techniques are maximum principle and the theory of monotone dynamical systems. This is a joint work with Prof. Hsu. Sze-Bi and Dr. Wang Fengbin.

30.

Hopf-pitchfork bifurcation in van der Pol's oscillator with nonlinear delayed feedback

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Abstract: First, we identify the critical values for Hopf-pitchfork bifurcation. Second, we derive the normal forms up to third order and their unfolding with original parameters in the system near the bifurcation point, by the normal form method and center manifold theory. Then we give a complete bifurcation diagram for original parameters of the system and obtain complete classifications of dynamics for the system. Furthermore, we find some interesting phenomena, such as the coexistence of two asymptotically stable states, two stable periodic orbits, and two attractive quasi-periodic motions, which are verified both theoretically and numerically.

31.

Determination and Prediction of the Global Responses Characteristics of A Piecewise Nonlinear Dynamical System

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Abstract: In this paper the global response characteristics of a four DOF piecewise nonlinear dynamical system, which is used to model the rotor/stator contact system, are studied. Two state-dependent switch conditions exist in the dynamical system and the states of the system are governed piecewisely by linear equations or by nonlinear equations. A systematic approach is proposed to determine the global response characteristics of this system, that is, to derive the different solutions in different pieces of system and analyze the stability of the solutions to get the existence boundaries of the different responses. After that, the existence boundaries of the dominant responses are drawn in the same parameter space to form an overall picture of the global response characteristics of this model. Furthermore, the system is also studied from the point view of normal modes. After derivation of the linear and nonlinear normal modes of the system, it is shown that some existence boundaries and their response characteristics of the above obtained responses can be well predicted from the interaction of the linear and the nonlinear normal modes, indicating that the normal modes can reveal some inherent features of the dynamical system.

32.

Modeling and analysis of influenza A(H1N1) on networks

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Abstract: April 2009, a new strain of H1N1 influenza virus, referred to influenza A pandemic (H1N1) was first detected in human in the United States, followed with an outbreak in the state of Veracruz, Mexico. Soon afterwards, this new virus kept spreading worldwide and cause the global outbreak.

In this talk, We formulate an epidemic model of influenza A based on networks. We obtain the disease-free equilibrium and study various immunization schemes of influenza A(H1N1). A final size relation is derived for the network epidemic model. The model parameters can be estimated via least-square fitting of the model solution to the observed data in China. Using the parameters, we compute the basic reproductive number to get $R_0 = 1.6809$ in China, and there are only 15 percent of the exposed become infected.

33.

Practical Stability Analysis of Linear Impulsive Hybrid Systems involving Fractional Derivatives

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Abstract: In this paper, practical stabilities for fractional impulsive hybrid systems are firstly investigated in detail. We interpret the transformation from a linear fractional differential system to a fractional impulsive hybrid system. With the help of the Mittag-Leffler functions for matrix-type, we derive several practical stability criteria for fractional impulsive hybrid systems. Finally, a numerical example is provided to illustrate the effectiveness of our results.

34.

Several problems in Fractional Ordinary Differential Equations

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Abstract: It has been found that fractional differential equations play a crucial role in modeling anomalous diffusion, time-dependent materials and processes with long-range dependence (LRD), allometric scaling laws, as well as power law in complex systems. In this talk, we focus on introducing applied theory and computation for fractional differential equations. Specifically, some main properties of fractional integral and fractional derivatives will be first introduced in brief with an emphasis on those important technical details that could be overlooked. And some possible applications have been also simply mentioned. In the last part, some recent results from the presenter's group on fractional ordinary differential equations such as stability analysis, numerical method, etc. will be introduced.

35.

Rearrangement Inequalities for Principal Eigenvalues of Integral Operators and Applications

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Abstract: In this talk, some new rearrangement inequalities for principal eigenvalues of nonsymmetric integral operators will be introduced and the applications on spreading speeds for monostable spatially periodic reaction-diffusion equations and integral difference equations will be considered.

36.

Spherically Symmetric Standing Waves for a Liquid/vapor Phase Transition Model

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Abstract: We study fluid flow involving liquid/vapor phase transition in a cone shaped section, simulating the flow in fuel injection nozzles. Assuming that the flow is spherically symmetric, and the fluid has high specific heat, we look for standing wave solutions inside the nozzle. The model is a system of viscous conservation laws coupled with a reaction-diffusion equation. We look for two types of standing waves-Explosion and Evaporation waves. If the diffusion coefficient, viscosity and typical reaction time are small, the system is singularly perturbed. Transition from liquid mixture to vapor occurs in an internal layer inside the nozzle. First, matched formal asymptotic solutions are obtained. Internal layer solutions are obtained by the shooting method. Then we look for a real solution near the approximation.

37.

Dynamical behavior of a three species food chain system with time delayed harvesting

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Abstract: A three species food chain model with time delayed harvesting is concerned. By using the theory of functional differential equation and Hassard's method, the conditions on which positive equilibrium exists and Hopf bifurcation occurs are given. Finally numerical simulations are performed to support the analytical results, and the chaotic behaviors are observed.

38.

Spatiotemporal variation of mistletoes: a dynamic modeling approach

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Abstract: Mistletoes are common aerial stem-parasites and their seeds are dispersed by fruit-eating birds. Mistletoes form mutually beneficial relationships with the bird species that disperse their seeds. The birds' preference for infected trees influences the spread of mistletoes. We formulate a deterministic model to describe the dynamics of mistletoes in an isolated patch containing n trees. We establish concrete criterions, expressed in terms of the model parameters, for mistletoes establishing in this area. We conduct numerical simulations based on a field test to reinforce and expand our results.

39.

Modeling and Application of Olfactory Bulb

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Abstract: Olfactory bulb is the basic message process unit of olfactory system. Based on the anatomical structure of olfactory bulb, we constructed an olfactory bulb network model, simulated the spike activity of olfactory neurons. The external influence to olfactory neurons are studied, various potential spike patterns are obtained. For different patterns stimulating, the spike of bulb neurons are changed greatly and these phenomena can be used as olfactory recognition. As to the electrophysiology experiment results about the action potential initiation and propagation in mitral cell, we have tested it by our model. The influence of external stimulus intensity to mitral cell primary dendrite on action potential initiation and propagation in mitral cell are studied. Analysis the blocking effect of inhibitory dendrite-dendrite synapse between mitral cell and granule cell to the action potential of mitral cell lateral dendrite. Combined with the two inhibitory interneurons in olfactory bulb(granule cell and periglomerular cell), we studied the four action potential initiation and propagation modes of mitral cell in olfactory bulb(Somatic initiation and back propagation, Dendritic initiation and local propagation, Dendritic initiation and forward propagation and Dendritic initiation and ping-pong propagation). Discussed mitral cell's different encoding characteristics to different excited synapse intensity from receptor cell to mitral cell.

40.

Critical structures of singularly perturbed problems of different types

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Abstract: In this talk, we will examine a number of singularly perturbed problems of different types. Depending on the normal hyperbolicity of the slow manifolds and the classes of turning points, the dynamical behavior varies dramatically. Critical structures for some of singular perturbation problems will be discussed.

41.

The applications of orthonormal splines in solving integral equations

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Abstract: In this paper, the orthonormal splines on small compact supports are applied in solving integral equations. The unknown function is expressed as a linear combination of orthonormal spline functions. Then a simple system of linear equations on the coefficients are deducted. It is relatively simple to solve the linear system and a good approximation of the original solution is obtained. The sufficient condition for the existence of the inverse matrix is discussed and the convergence is investigated.

42.

Modulational Instability for Dark Soliton Stripes in External Potentials: Controlling the Number of Nucleated Vortices in Bose-Einstein Condensates

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Abstract: We study the modulational instability of dark soliton stripes in two-dimensional Bose-Einstein condensates. By adding an external barrier potential, in the form of a one-dimensional laser beam with a Gaussian profile, it is possible to systematically control the window of wavenumbers that are modulationally unstable and even render a dark soliton stripe completely stable. By doing so, it is possible to control the amount of vortex pairs that will nucleate from each period of the modulation. Using perturbation theory we analytically develop a criterion predicting the number of nucleated vortices per unit length. The analytical results are corroborated by numerically computing the (ins)stability eigenmodes of the steady states as well as by direct numerical integration of the ensuing Gross-Pitaevskii equation.

43.

Sewing Connection of Difference Differential Equations for Singularly Perturbed Problems

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Abstract: The research for singularly perturbed problems of differential difference equations with initial boundary value problems has a large number of results. Most of these works are based on the proof of the existence of solutions, and use the differential inequality methods mostly. However, knowing the structure of solutions and obtaining the asymptotic expressions to be especially important in practical application and design algorithm. For this purpose, in this paper in view of several types of singularly perturbed differential difference equations with boundary value problems, we not only prove the existence of smooth solutions with interior layer but also construct uniformly valid asymptotic solution. The method which used here is called "Sewing Connection", and has shown great vitality in research of singular perturbation problems with contrast structures.

44.

Deformation and rotational motion of traveling spots

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Abstract: What is the origin of rotational motion? An answer is presented through the study of the dynamics for spatially localized spots near codimension 2 singularity consisting of drift and peanut instabilities. The drift instability causes a head-tail asymmetry in spot shape, and the peanut one implies a deformation from circular to peanut shape. Rotational motion of spots can be produced by combining these instabilities in a class of three-component reaction diffusion systems. PDE dynamics can be reduced to a finite dimensional one by projecting it to slow modes. Such a reduction clarifies the bifurcational origin of rotational motion of traveling spots in two dimensions in close analogy to the normal form of 1:2 mode interactions.

45.

Population Dynamics with Age-dependent Diffusion and Death Rates

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Abstract: In this talk we present the population dynamics of a species with age structure in the case where the diffusion and death rates of the matured population are both age-dependent. A completely new model in terms of an integral equation is constructed. For unbounded spatial domain, we investigated the existence of traveling waves, while in bounded domain, we investigated the existence of positive steady-state solutions and their stability for different choices of birth function. As a by-product, we also prove rigorously the existence of real principal eigenvalue with positive eigenfunctions.

46.

Effects of technological delay on insulin and blood glucose in a physiological model

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Abstract: The dynamics of the physiological model describing the diabetic treatment with the external auxiliary system, i.e., the artificial pancreas, is considered in this paper. There are two time delays, i.e., technological and livers physiological delay in this model. Double Hopf bifurcations with resonance and non-resonance exist in the model due to the technological delay. The classification and unfolding of the nonresonant double Hopf bifurcation are

performed in terms of nonlinear dynamics. The obtained results show that the model may be employed to predict the artificial pancreas (AP) efficiency with varying the technological delay and the affection degree. It implies if the diabetic patients recover or are still tormented by the simple or complex glucose fluctuation. The results have also been promising applications on analyzing, predicting and optimizing the medical outcome, evaluating the medical risk and feasibility. The physiological meaning in this paper is that one is able to achieve the better medical outcomes for the different patients with affection degrees by regulating the technological delay qualitatively.

47.

Periodic and Quasi-periodic Dynamics of Bose-Einstein Condensates

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Abstract: In this talk, we consider periodic and quasi-periodic modulated amplitude waves (MAW) of Bose-Einstein Condensates(BEC).

We derive amplitude equations describing the evolution of spatially modulated states of the BEC, which correspond to some singular oscillators.

For one-component BEC, we prove the existence of infinitely many quasi-periodic MAW with nonzero angle momentum and the boundedness of all wave functions with coherent structure ansatzs by using Morse's twist theorem.

For two-component BEC which corresponds to a singular coupled system, we prove the existence of periodic MAW with nonzero angle momentum by using a new high dimensional twist theorem for fixed point.

48.

Integrable peakon and cuspon equations

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Abstract: In my talk, I will introduce integrable peakon and cuspon equations and present a basic approach how to get peakon solutions. Those equations include the well-known Camassa-Holm (CH), the Degasperis-Procesi (DP), and other new peakon equations with M/W-shape solutions. I take the CH case as a typical example to explain the details. My presentation is based on my previous work (Communications in Mathematical Physics 239, 309-341). I will show that the Camassa-Holm (CH) spectral problem yields two different integrable hierarchies of nonlinear evolution equations (NLEEs), one is of negative order CH hierarchy while the other one is of positive order CH hierarchy. The two CH hierarchies possess the zero curvature representations through solving a key matrix equation. We see that the well-known CH equation is included in the negative order CH hierarchy while the Dym

type equation is included in the positive order CH hierarchy. Furthermore, under two constraint conditions between the potentials and the eigenfunctions, the CH spectral problem is cast in: 1. a new Neumann-like N-dimensional system when it is restricted into a symplectic submanifold of R^{2N}, which is proven to be integrable by using the Dirac-Poisson bracket and the r-matrix process; and 2. a new Bargmann-like N-dimensional system when it is considered in the whole R^{2N}, which is proven to be integrable by using the standard Poisson bracket and the r-matrix process. The whole CH hierarchy (both positive and negative orders) is shown to have the parametric solutions, which obey the corresponding constraint relation. In particular, the CH equation, constrained to a symplectic submanifold in R^2N, has the parametric solutions. Moreover, solving the parametric representation of the solution on the symplectic submanifold gives a class of a new algebro-geometric solution of the CH equation. In the end of my talk, some open problems are also addressed for discussion.

49.

Monotonicity and Sliding States in the Overdamped Particle Chains

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Abstract: In this talk we are mainly concerned with the monotonicity in the overdamped particle chains and its applications to the existence and modulation of the uniform sliding states. We will first give a brief introduction on the theory of monotone dynamical systems, and then use the general criteria to determine the conditions under which the damped particles chain model is monotone. The overdamped condition for the linear damping case is thus obtained to ensure the monotonicity of the particles chain model. Furthermore, we investigate the monotonicity of the specific Frenkel-Kontorova (FK) model with nonlinear damping, which corresponds to the coupled Josephson junctions with interference term. we will also discuss the monotonicity of the underdamped case of the FK model. Combining the monotonicity with the theory of dynamical systems, we obtain a series of consequences on the existence and modulation of the sliding states and some properties of the pinning-depinning transition.

50.

Stability and Bifurcation of Rotating Waves in nonlinear equations of Schrödinger type

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Abstract: This talk is concerned with nonlinear equations of Schrödinger type, posed on the one dimensional torus. In this situation, there exists infinitely many family of rotating waves, associated with each rotation number which is a nonzero integer. We study the orbital stability of these families of rotating waves and give sufficient conditions for stability in terms of the rotation number and wave speed, to the effect that waves of positive rotation number

are stable for sufficiently large wave speed. We also prove the existence of bifurcations from rotating waves. Bifurcated solutions exhibit amplitude modulations of differing periods. Also, an attempt is made to generalize these results to higher dimensional tori.

51.

Periodic Solutions to Impulsive Duffing Equations via Poincaré-Birkhoff Fixed Point Theorem

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Abstract: This paper studies the existence of periodic solutions to the impulsive Duffing equation

$$\begin{cases} x'' + g(x) = 0, \quad t \neq \theta_k, \\ x(\theta_k^+) = a_k x(\theta_k), \\ x'(\theta_k^+) = b_k x'(\theta_k), \end{cases}$$

where the function $g \in C(R, R)$ is assume to be sublinear at the origin in the sense

$$\lim_{x \to 0} \frac{g(x)}{x} = +\infty.$$

Existence of infinitely many periodic solutions is proved via the Poincaré-Birkhoff fixed point theorem.

52.

Spreading Speeds for Monostable Equations with Nonlocal Dispersal in Space Periodic Habitats

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Abstract: This talk is concerned with spatial spreading dynamics of monostable equations with nonlocal dispersal in spatially periodic habitats. In particular, the existence and characterization of spreading speeds is considered. First, a principal eigenvalue theory for nonlocal dispersal operators with space periodic dependence is developed, which plays an important role in the study of spreading speeds of nonlocal periodic monostable equations and is also of independent interest. In terms of the principal eigenvalue theory it is then shown that the monostable equation with nonlocal dispersal has a spreading speed in every direction in the following cases: the nonlocal dispersal is nearly local; the periodic habitat is nearly globally homogeneous or it is nearly homogeneous in a region where it is most conducive to population growth in the zero-limit population. Moreover, a variational principle for the spreading speeds is established. This is a joint work with Aijun Zhang.

53.

Rank Deficiencies and Bifurcation into Affine Subspaces for Separable Parameterized Equations

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Abstract: Many applications lead to separable parameterized equations of the form $F(y, \mu, z) \equiv A(y, \mu)z + b(y, \mu) = 0$, where $y \in R^n$, $z \in R^N$, $\mu \in R$ is a parameter, $A(y, \mu) \in R^{(N+n)\times N}$ and $b(y, \mu) \in R^{N+n}$. Typically $N \gg n$. When bifurcation occurs at a solution point (y^*, μ^*, z^*) of this equation, $F'(y^*, \mu^*, z^*)$ is rank deficient; when $A(y^*, \mu^*)$ is also rank deficient then bifurcation into an affine subspace occurs. We develop a variant of the Golub-Pereyra variable projection method to reduce the original system to a smaller separable system, while preserving the bifurcation and the rank deficiencies. When N is much larger than n, as occurs in discretizations of differential equations, the reduction of dimension is significant. A numerical algorithm and examples illustrating the method are provided.

54.

Predator-prey model with strong Allee effect on prey population

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Abstract: Classical Rosenzweig-MacArthur predator-prey model assumes a logistic growth for the prey population. A strong Allee effect on the prey population introduces a population threshold. The dynamics of ODE model is completely classified, with phenomena of Hopf bifurcation, unique limit cycle, and heteroclinic loop. The dynamics, bifurcations, and a priori estimates for the PDE model will also be discussed. The talk is based on joint work with Jinfeng Wang and Junjie Wei.

55.

Chaos in non-autonomous discrete dynamical systems

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Abstract: Discrete dynamical systems can be divided into autonomous discrete systems and non-autonomous discrete systems. An autonomous discrete system is generated by a single map with iteration, while a non-autonomous discrete system is generated by a sequence of maps with iteration. Obviously, dynamical behaviors of non-autonomous discrete systems are more complicated in general. Recently, we studied chaos in non-autonomous discrete systems.

In this talk, we first introduce some basic concepts for general non-autonomous discrete systems, including definitions of chaos, topological conjugacy, and coupled-expansion for transition matrix. Secondly, we discuss chaotic dynamical behaviors of finite-dimensional linear non-autonomous discrete systems. We shall present some interesting observations and give some conditions under which a finite-dimensional linear system exhibits chaos in the sense of Li-Yorke. Thirdly, we study some properties of topological conjugacy for non-autonomous systems, which are different from those for autonomous systems. This yields some difficulty in the study of chaos in non-autonomous systems. Fourthly, we give a criterion of chaos induced by strict coupled-expansion for non-autonomous discrete systems in metric spaces. Finally, we provide several illustrative examples with computer simulations. This talk is based on a joint work with Professor Guanrong Chen.

56.

Impact of Intracellular Delays and Target-Cell Dynamics on in vivo Viral Infections

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Abstract: The dynamics of an in-host model with general form of target-cell dynamics, nonlinear incidence and distributed delay are investigated. The model can describe the in vivo infection dynamics of many viruses such as HIV-I, HCV and HBV. We derive the basic reproduction number R_0 for the viral infection, and establish that the global dynamics are completely determined by the values of R_0: if $R_0 \leq 1$, the infection-free equilibrium is globally asymptotically stable, and the virus are cleared; if $R_0 > 1$, then the infection persists and the chronic-infection equilibrium is globally asymptotically stable. An implication of our results is that intracellular delays will lead to periodic oscillations in in-host models only with the right kind of target-cell dynamics.

57.

Fold, Hopf and fold-Hopf bifurcations in delay differential equations with application to a damped harmonic oscillator with delayed feedback

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Abstract: In this talk, we address the explicit calculation formulas of normal form on the center manifold with the unfolding for general delay differential equations under the cases of fold, Hopf and fold-Hopf bifurcations singularities, which is the generalization of the corresponding results for a scalar delay differential equation due to Faria Teresa *et al.* Using the results obtained here, we give a complete description of bifurcation scenario of the damped harmonic oscillator with delayed feedback near the zero equilibrium.

58.

Effect of time delay on a detritus based ecosystem

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Abstract: In this paper we formulate a mathematical model of a detritus based autotroph - herbivore ecosystem with discrete and distributed delay nutrient recycling. Delay here presents the time required for detritus decomposition. We have studied the growth of autotroph and herbivore population depending on the limiting nutrient which is partially recycled through decomposition. It has been shown that the supply rate of external resources plays an important role in shaping the dynamics of the autotroph-herbivore ecosystem. We have derived conditions for delay-induced asymptotic stability, stability switching of the steady state and periodic solutions bifurcating from the steady state. The length of the delay preserving the stability has also been derived.

59.

Global stability of the endemic equilibrium of multigroup SIR model with nonlinear incidence

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Abstract: We introduce a basic reproduction number for a multigroup epidemic model with nonlinear incidence. Then, we establish that global dynamics are completely determined by the basic reproduction number R_0. It shows that, the basic reproduction number R_0 is a global threshold parameter in the sense that if it is less than or equal to one, the disease free equilibrium is globally stable and the disease dies out; whereas if it is larger than one, there is a unique endemic equilibrium which is globally stable and thus the disease persists in the population. Finally, a numerical example is also included to illustrate the effectiveness of the proposed result.

60.

Collapse of patterns in activator-inhibitor systems

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Abstract: "Collapse of patterns" is a phenomena numerically observed in a certain reaction-diffusion systems comprised of an activator and an inhibitor: Starting from an almost constant initial data, the solution develops spatial inhomogeneity for a while, then it starts to oscillate, and eventually converges to a state where the activator vanishes identically. Whether

patterns collapse or not depends on the existence of basic production terms in each of the equations. Here the basic production term refers to the term independent of the activator and the inhibitor. In this talk we prove rigorously that there exists a small amplitude stable stationary solution which attracts a wide range of nonstationary solutions with large initial data, provided that the activator has a small basic production term and the inhibitor has a nontrivial basic production term. Also, in the case where both the basic production terms are missing we give a sufficient condition on the initial data for the solution to converge uniformly to zero.

61.

Lyapunov inequalities and stability for Hamiltonian systems

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Abstract: In this talk, we first introduce some known results relating the Lyapunov inequalities for second-order differential equation and the planar linear Hamiltonian system. Then, we give some new Lyapunov inequalities for $2n$-dimension linear Hamiltonian system and the planar linear Hamiltonian system. Last, we give some new stability criteria for the planar linear Hamiltonian system.

62.

Hopf bifurcations for neutral functional differential equaions with infinite delay

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Abstract: In the theory of linear autonomous neutral functional differential equations with infinite delay, the spectrum distribution of the infinitesimal generator of its solution operators is studied under a certain phase space. Thereafter, we prove the representation theorem of the solution operators, which is later employed to obtain exponential dichotomy properties in terms of semigroup theory.Formal adjoint theory for linear autonomous NFDEs with infinite delay is established including such topics as formal adjoint equations, the relationship between the formal adjoint and true adjoint, and decomposing the phase space with formal adjoint equation. Finally, the algorithm for calculating the Hopf bifurcation properties for nonlinear NFDEs with infinite delay is presented based on the theory of linear equations.

63.

Nontrivial periodic solutions for second order non-autonomous delay differential equations

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Abstract: By using Morse theory and Galerkin method, some new results on the existence of nontrivial periodic solutions to the system of delay differential equations $z''(t) = -f(t, z(t-\tau))$ are obtained, where $\tau > 0$ is is a constant, and f is $\tau-$ periodic in the first variable. The discussion permits resonance both at infinity and the origin.

64.

Mather Theory for The Flow of Geodesics on Surfaces

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Abstract: We will talk about some recent results on the Mather theory for the flows of geodesic on compact surfaces. Specifically, we will give the finer description of the structure of minimal measures with rational rotation vectors for the flows of geodesic on compact surfaces of higher genus.

65.

Threshold Dynamics in Disease Models with Latency and Relapse

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Abstract: In this talk, I will present a general mathematical model for a disease with an exposed (latent) period and relapse. Such a model is appropriate for tuberculosis, including bovine tuberculosis in cattle and wildlife, and for herpes. For this model with a general probability of remaining in the exposed class, the basic reproduction number is identified and its threshold property is discussed. Two special cases, which result in an ODE system and a DDE system, respectively, are discussed in details.

66.

Traveling wave solutions in delayed nonlocal diffusion systems with mixed monotonicity

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Abstract: This talk deals with the existence of traveling wave solutions in delayed nonlocal diffusion systems with mixed monotonicity. Based on two different mixed-quasimonotonicity reaction terms, we propose new definitions of upper and lower solutions. By using Schauder's fixed point theorem and a new cross-iteration scheme, we reduce the existence of traveling wave solutions to the existence of a pair of upper and lower solutions. The obtained results can be applied to type-K monotone and type-K competitive nonlocal diffusive Lotka–Volterra systems. This is a joint work with Kai Zhou.

67.

A dynamical model for the mammalian circadian clock with microRNAs

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The mammalian circadian behavior has been studied for many years and many mathematical models have been proposed so far. The significant roles of microRNAs in gene regulation have been characterized these years. Although the crucial roles of microRNAs in almost all cellular processes, the mechanisms still need to be fully understood. Based on the recent experimental results on microRNAs in modulation of circadian clock, we propose a novel model for the mammalian circadian clock with microRNA-219 and microRNA-132. Besides explaining the experimental results, some other complex dynamics may occur. Moreover, some interesting predictions are also made.

68.

On the conformal invariance and Loewner equation

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Abstract: We will talk about conformal invariance with connection to the Loewner equation driving by Brownian motion.

69.

Traveling Waves in Chemotaxis

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Abstract: The chemotaxis describes the cell directed movement towards the concentration gradient of the chemical (or signal). The chemotaxis model was firstly proposed by Keller and Segel on 1971 to explain the wave patterns of bacteria chemotaxis observed in experiment.

In this talk, I will show some recent analytical and numerical development on the existence and stability of traveling waves of the original Keller-Segel model. Particularly I will connect the Keller-Segel model to the Fisher equation and conservation laws although their origins are very different.

70.

Asymptotic speed of propagation and traveling wavefronts for a SIR epidemic model

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Abstract: In the present article, we will consider a SIR model incorporated with age-structure and nonlocal spatial diffusion:
(3)
$$\begin{cases} \dfrac{\partial u_1}{\partial t} = D_1\dfrac{\partial^2 u_1}{\partial x^2} + B(u_2(t,x)) - \gamma u_1(t,x) - e^{-\gamma\tau}\int_R \frac{1}{\sqrt{4\pi D_1\tau}} e^{-\frac{(x-y)^2}{4D_1\tau}} B(u_2(t-\tau,y))dy, \\ \dfrac{\partial u_2}{\partial t} = D_2\dfrac{\partial^2 u_1}{\partial x^2} + e^{-\gamma\tau}\int_R \frac{1}{\sqrt{4\pi D_2\tau}} e^{-\frac{(x-y)^2}{4D_1\tau}} B(u_2(t-\tau,y))dy - d(u_2(t,x)) - U(u_2(t,x)), \\ \dfrac{\partial u_3}{\partial t} = D_3\dfrac{\partial^2 u_3}{\partial x^2} + U(u_2(t,x)) - bu_3(t,x) - ru_3(t,x), \end{cases}$$

for $t \in R+$, $x \in R$, where $u_1(t;x)$, $u_2(t;x)$ and $u_3(t;x)$ denote respectively the densities of juvenile, susceptible mature and infective individuals at time t and location x . It is assumed that only the mature individuals are susceptible. This assumption is reasonable for some epidemics, such as typhus, diphtheria and sexually transmitted diseases. $B(\cdot)$ is a birth function and $d(\cdot)$ is a death function. The susceptible individuals, once infected, can act as the infectious agent and then transmit the infections. Let $U(u_2)$ be the force of infection on the mature population due to a concentration of the infectious agent u_2. $b, r > 0$ denote respectively the death rate and recovery rate of infective individuals. The well-posedness of the initial value problem, the existence of traveling wavefronts and the asymptotic speed of propagation for (3) are studied. We further show that the minimum wave speed in fact coincides with the asymptotic speed of propagation.

71.

On the Generalized Hartman-Grobman Problem on Time Scales

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Abstract: This paper devotes to studying topological classification of non-autonomous dynamic equations on time scales (continuous and discrete systems in a unified manner). The first purpose of this talk is to correct a mistake in [C.Pötzche, Topological decoupling, linearization and perturbation on inhomogeneous time scales, J. Diff. Equ., 2008] and give a

rigorous proof. A counterexample is presented to illustrate that his definitions of "topological conjugacy" on time scales contradicts to his remark[Remark 4.2, pp1231]. There is a contradiction between the traditional definitions and the aim of topological classification, say, the traditional definitions can not ensure that the trivial solutions of two topologically conjugated systems have the same stability. However, it is normally expected that the two topologically conjugated systems have same topological structure and asymptotic behaviors (e.g. bounded, stable and asymptotically stable). To deal with this paradox, we introduce the concept of strongly topological conjugacy on time scales. The second aim is to revisit Hartman-Grobman Problem in a Unified Manner. A new version of generalized Hartman-Grobman theorem on time scales is obtained to guarantee that the nonlinear system $x^{\Delta} = A(t)x + f(t, x)$ is strongly topologically conjugated to its linear part $x^{\Delta} = A(t)x$.

72.

On the number of limit cycles in small perturbations of hyperelliptic Hamiltonian systems

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Abstract: In this talk, we will introduce some studies on small perturbations of Hamiltonian vector field with a hyper-elliptic Hamiltonian of degree five, which is a Liénard system of the form $x' = y$, $y' = Q_1(x) + \varepsilon y Q_2(x)$ with Q_1 and Q_2 polynomials. It is shown that the maximum number of isolated zeros (multiplicity taken into account) for the related Abelian integrals is the same to the degree of $Q_2(x)$ for a few classes of system. And the number of limit cycles of the system is discussed in the plane for sufficiently small parameter ε.

73.

Super Central Configurations and Geometrical Equivalence in the Newtonian n-body Problem

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Abstract: A central configuration is a configuration of bodies $q = (q_1, q_2, \cdots, q_n)$ with mass vector $m = (m_1, m_2, \cdots, m_n)$ such that the acceleration vector for each body is a common scalar multiple of its position vector. The question on the number of central configurations for a given mass vector $m = (m_1, m_2, \cdots, m_n) \in (\mathbf{R}^+)^n$ is still a challenging problem for 21st century's mathematicians. In history, there are three different understandings of the equivalence of central configurations in the Newtonian n-body problem and they are called *permutation equivalence, mass equivalence*, and *geometrical equivalence*. Euler found three collinear central configurations and Moulton generalized to $n!/2$ central configurations for the collinear n-body problem in permutation equivalence. But the number of central configurations in geometrical equivalence is still unknown for general n. We discovered that the

number of central configurations in geometrical equivalence is closely related to the super central configurations. A super central configuration is a configuration which is a central configuration for both the given mass m and some permutation of m. In this talk, we show that the super central configurations decrease the number of central configurations in the geometrical equivalence in the collinear three- and four-body problems.

74.

On the number of critical periods for planar polynomial systems of arbitrary degree

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Abstract: In my talk I will introduce one of our recent results with Armengol Gasull and Changjian Liu about the number of critical periods for polynomial systems of degree n. By explicitly constructing a class of polynomial systems of arbitrary degree n having a reversible center at the origin, we show that the number grows quadratically with n, i.e. it can grow at the speed of $\sim n^2$. As far as we know, all the previous results on this subject only exhibit linear growth with n, i.e., $\sim n$.

75.

Complex dynamics of the chaotic system with one saddle and two stable node-foci

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Abstract: This paper reports the finding of a chaotic system with one saddle and two stable node-foci in a simple three-dimensional (3D) autonomous system. The system connects the original Lorenz system and the original Chen system and represents a transition from one to the other. The algebraical form of the chaotic attractor is very similar to the Lorenz-type systems but they are different and, in fact, non-equivalent in topological structures. Of particular interest is the fact that the chaotic attractor has one saddle and two stable node-foci. To further understand the complex dynamics of the system, the local dynamics, such as the number of equilibria, the stability of hyperbolic equilibria and the stability of non-hyperbolic equilibrium by using the center manifold theorem, the pitchfork bifurcation and the degenerate pitchfork bifurcation, Hopf bifurcations and the local manifold character are all analyzed when the parameters are varied in the space of parameters. The global dynamics are also rigorously studied. More exactly, under certain conditions, we prove that system has no homoclinic orbit but has two and only two heteroclinic orbits.

76.

Determining Controllability of Snakeboard by Lie algebra and differential Forms– A brief introduction to geometric control and locomotion

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Abstract: Geometric control theory is a fascinating branch of Mathematics where differential geometry, dynamical systems and control theory meet and has broad applications in mechanical systems and animal locomotion. In this talk we try to show this flavor. First we give a brief introduction to nonholonomic systems and some basic notions and theorems of geometric control, then we show how to determine controllability of Snakeboard via Lie algebra of vector fields and differential forms. Finally we touch upon the connection of principal bundles with animal locomotion.

77.

Models of Cell Cycle Dynamics and Clustering

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Abstract: Biologists have long observed periodic-like oxygen consumption oscillations in yeast populations under certain conditions and several explanations for this phenomenon have been proposed. We hypothesize that these oscillations could be caused by cell cycle synchronization or clustering. We develop very general ODE models of the cell cycle. For these models, and for random perturbations, we give rigorous proofs that both positive and negative feedback can lead to clustering of populations within the cell cycle. These results suggest that the clustering phenomenon is robust and is likely to be observed in nature. Related experiments, guided by the mathematical results, have shown conclusively that cell cycle clustering occurs in some oscillating yeast cultures.

Joint work with: E. Bozcko (Vanderbilt), B. Fernandez (Marseille)

78.

Homoclinic Bifurcation Satisfying the Small Lobe Condition

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Abstract: Period-adding cascades with chaos manifest themselves in an alternating periodic-chaotic sequence when the control parameter is changed. The periodic states are characterized by combinations of relatively big and small windings in phase space and are referred to

as mixed-mode oscillations (MMOs) or bursting. In this paper, we use the continuation method to detect period-adding cascades with chaos in a reduced leech neuron model, whose mechanism is suggested as the bifurcation of a saddle-node limit cycle with homoclinic orbits satisfying the "small lobe condition". This neuron model is probably the first realistic physical system exhibiting the small lobe saddle-node homoclinic bifurcation. In every spiking adding, the new spike emerges at the end of the spiking phase of the bursters.

79.

The uniqueness problem of periodic solutions for the the equation $\dot{x}(t) = -f(x(t-1))$

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Abstract: In this talk, we will study the uniqueness of periodic solutions of the following differential delay equation

$$\dot{x}(t) = -f(x(t-1))$$

where $f : R \to R$ is odd and continuous, and $xf(x) > 0$ for $x \neq 0$. We proved that if $\frac{f(x)}{x}$ is monotone for $x > 0$ and $\frac{f(x)}{x} \neq$ constant in a neighborhood of $x = 0$, then the equation has at most one periodic solution with minimal period 4 and the symmetric structure $x(t) = -x(t-2)$. We also prove that if $\frac{f(x)}{x} \geq \frac{\pi}{2}$ (or $\leq \frac{\pi}{2}$) for $x \neq 0$ and $\frac{f(x)}{x} \neq$ constant in a neighborhood of $x = 0$, then the equation has no such periodic solutions. We say that two solutions $x_1(t)$ and $x_2(t)$ are identical if there exists a constant r such that $x_1(t) = x_2(t+r)$, for any $t \in R$. A generalization to equations with two delays is also proved.

80.

Four limit cycles in quadratic near-integrable polynomial systems

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Abstract: In this talk, we shall show that when a quadratic integrable system has two centers and is perturbed by quadratic polynomials, it can generate at least 4 limit cycles with (3,1) distribution. The method of Melnikov function is used.

81.

Matter-wave solitons and finite-amplitude Bloch waves in optical lattices with a spatially modulated nonlinearity

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Abstract:We investigate solitons and nonlinear Bloch waves in Bose-Einstein condensates trapped in optical lattices. By introducing specially designed localized proles of the spatial modulation of the attractive nonlinearity, we construct an infinite number of exact soliton solutions in terms of the Mathieu and elliptic functions, with the chemical potential belonging to the semi-infinite bandgap of the optical-lattice-induced spectrum. Starting from the exact solutions, we employ the relaxation method to construct generic families of soliton solutions in a numerical form. The stability of the solitons is investigated through the computation of the eigenvalues for small perturbations, and also by direct simulations. Finally, we demonstrate a virtually exact (in the numerical sense) composition relation between nonlinear Bloch waves and solitons.

[1] Y. Zhang and B. Wu, PRL102, 093905 (2009); Y. Zhang, Z. Liang, and B. Wu, PRA80, 063815 (2009).
[2] J. Belmonte Beitia, V. M. Perez Garcia, V.Vekslerchik, and V. V. Konotop, PRL100, 164102 (2008).

82.

Small perturbations of maps with snap-back repellers in Banach spaces

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Abstract: In this talk, we present several results about small perturbations of a class of chaotic discrete systems in Banach spaces. We obtain that if a map has a regular and nondegenerate snap-back repeller, then it still has a regular and nondegenerate snap-back repeller under sufficiently small perturbation. Hence, the perturbed system is chaotic in the sense of both Devaney and Li-Yorke. In order to study structural stability of a map with a regular and nondegenerate snap-back repeller, we first show that a strictly A-coupled-expanding map in a Banach space is C^1 structurally stable on its compact chaotic invariant set under certain conditions. Applying this result, we prove that a map with a regular and nondegenerate snap-back repeller in a Banach space is C^1 structurally stable on its chaotic invariant set.

83.

Analytic normalization of analytic integrable systems: degenerate case

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Abstract: Consider analytic integrable systems $\dot{x} = Ax + f(x)$ with $x \in C^n$ and $f(x) = O(|x|^2)$. In [J. Diff. Eqns. 244(2008), 1080–1092] we proved that if A is nondegenerate and semi–simple, then the system is analytically equivalent to its normal form. The result in this talk will release the restrictions on nondegenerate and semi–simple, that is, we will prove that if A has nonzero eigenvalues, then the analytically integrable differential system is locally analytically equivalent to its normal form.

Second we will prove that any analytically integrable diffeomorphism can be embedded in an analytically integrable flow.

Using the embedding result we get that any analytically integrable diffeomorphism $F(x) = Bx + f(x)$ with $f(x) = O(|x|^2)$ and B having at least one eigenvalues not on the unit circle of C, is analytically conjugate to its normal form.

84.

A-coupled-expanding maps in compact sets

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Abstract: In this talk, we present several results about strictly A-coupled-expanding maps in compact subsets of metric spaces, where $A = (a_{ij})$ is an $m \times m$ irreducible transition matrix with one row-sum no less than 2. A map f is said to be strictly A-coupled-expanding in m sets V_i if $f(V_i) \supset V_j$ whenever $a_{ij} = 1$ and the distance between any two different sets of these V_i is positive. Based on a new result about the subshift for matrix A, it is shown that the maps are chaotic in the sense of Li-Yorke. In the one-dimensional case on nondegenerate compact intervals, it is further proved that the maps are chaotic in the sense of both Li-Yorke and Devaney.

This talk is based on a joint work with Yuming Shi and Guanrong Chen.

85.

Maximum Likelihood Decoding of Neuronal Inputs from an Interspike Interval Distribution

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Abstract: An expression for the probability distribution of the interspike interval of a leaky integrate-and-fire (LIF) model neuron is rigorously derived, based on recent theoretical developments in the theory of stochastic processes. This enables us to find for the first time a way of developing maximum likelihood estimates (MLE) of the input information (e.g., afferent rate and variance) for an LIF neuron from a set of recorded spike trains. Dynamic inputs to pools of LIF neurons both with and without interactions are efficiently and reliably decoded by applying the MLE, even within time windows as short as 25 msec.

86.

Exact solutions of the generalized nonlinear Schrödinger equation related to Boes-Einstein condensates

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Abstract: In this paper, a class of exact solutions of the generalized nonlinear Schrödinger equation are investigated. With a novel transformation, once the exact solutions of the nonlinear Schrödinger equation are provided, several families of new exact dark and bright solutions are obtained for the generalized nonlinear Schrödinger equation equation. Furthermore, based on Jacobi theta functions, periodic-like solutions, which are periodic in x, are explicitly presented.

87.

Periodic Orbits and Non-integrability for a Class of Four-dimensional Lotka-Volterra Systems

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Abstract: This talk deals with a class of four-dimensional Lotka-Volterra(LV) system admitting a non-canonical hamiltonian structure. The results obtained shown that the LV system possesses at least three different families of periodic solutions for generic parameters, and that it is nonintegrable for small $a_{23} \neq 0$ and Hamiltonian chaos can emerge.

88.

Bistable Waves for Monotone Semiflows With Applications

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Abstract: In this talk, I will report our recent research on traveling waves for monotone evolution systems with bistable nonlinearities. Under an abstract setting, we establish the existence of bistable waves for monotone (discrete and continuous-time) semiflows. This result is also extended to monotone semiflows in a periodic habitat. We also apply our developed theory to a time-periodic reaction-diffusion system, a parabolic system in a cylinder, and a nonlocal and time-delayed reaction-diffusion equation. This talk is based on a joint work with Jian Fang.

89.

Recent advances in the weakened Hilbert 16th problem for quadratic systems Q_3^R and Q_4

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Abstract: This talk is concerned with the the weakened Hibert 16th problem for quadratic systems under quadratic perturbations. We will recall the history of this problem, and then introduce some recent results this direction. The upper bound of the number of limit cycles are given for several specific kind of quadratic reversible Q_3^R. We also set an upper bound for the cyclicity of quadratic codimension four centers Q_4 under quadratic perturbation.

The results are contained in several papers,published or unpublished, collaborated with Haihuang Liang and Yi Shao.

90.

Exponential Attractor for KGS Lattice System

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Abstract: We first present some sufficient conditions for the existence of an exponential attractor of lattice dynamical systems. Then we consider the existence of exponential attractor of Klein-Gordon-Schrödinger lattice system (This work was joined with Caidi Zhao and Yanju Zhao).

91.

Dynamics of Biological network modules

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Abstract: There exist plentiful, relatively independent, function-specific network modules in biological systems. From viewpoints of dynamics, revealing structure and function of these simple networks is highly important for understanding regulatory mechanisms of more complicated networks and even for understanding intracellular processes, and is also greatly helpful for elucidating design principles of biological networks. In this talk, I will simply introduce some progress in the related study in combination with our group's latest results, focusing on mathematical modeling, numerical computation and theoretical analysis. Hopefully, my introduction can bring some interest in studying biological networks.

92.

On the existence of homoclinic solutions of a class of discrete nonlinear periodic systems

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Abstract: In this talk, we introduce some new sufficient conditions on the existence of homoclinic solutions of a class of discrete nonlinear periodic systems, which are also necessary in some special cases. The method is based on critical point theory in combination with periodic approximations. This is a joint work with Jianshe Yu.

93.

The Cyclicity of a Class of Quadratic Vector Field With Nilpotent Graphics

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Abstract: In this talk, I will introduce the study of the exact cyclicity (maximum number of limit cycles) in a class of quadratic vector fields with a center and a family of nilpotent graphics. By using global blow-up technique, I will show you that the bifurcation of the graphics with a nilpotent point will gives rise to at most two limit cycles. Iliev proved that the bifurcation of the center in such family can generate at most three limit cycles, then we can conclude that this family of quadratic vector fields have cyclicity equals to 4.

94.

Stochastic averaging method for quasi Hamiltonian systems and its Applications

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Abstract: In many real nonlinear stochastic systems, it often can be identified the rapidly varying and slowly varying response processes. The stochastic averaging method is to average the response with respect to the rapidly varying processes to yield the averaged It? stochastic differential equations for slowly varying processes, which are much simpler and of less dimension than the original equations. The response of the systems can then be obtained by solving the averaged FPK equation associated with averaged It? equations. There are mainly two versions of the classical stochastic averaging method, i.e., the standard stochastic averaging method and the stochastic averaging of energy envelope or quasi-conservative averaging. In the last decades, the stochastic averaging method for quasi Hamiltonian systems has been developed in mechanics, which can be applied to many-degree-of-freedom strongly nonlinear stochastic systems. In this lecture, the stochastic averaging method for quasi Hamiltonian systems in five cases is briefly introduced and two examples, including active Brownian particle dynamics and time-delayed feedback controls, are given to illustrate the application of the stochastic averaging method for quasi Hamiltonian systems.

95.

Map dynamics versus dynamics of associated delay R-D equation with Neumann condition

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Abstract: we consider a class of delay reaction diffusion equations (DRDE) with a parameter $\varepsilon > 0$. Homogeneous Neumann boundary condition and non-negative initial functions are posed to the equation. By letting $\varepsilon \to 0$, such an equation is formally reduced to a scalar difference equation (or map dynamical system). The main concern is the relation of the absolutely (or delay independent) global stability of a steady state of the equation and the dynamics of the nonlinear map in the equation. By employing the idea of attracting intervals for solution semiflows of the DRDE, we prove that the globally stable dynamics of the map indeed ensures the delay independent global stability of a constant steady state of the DRDE. We also give a counterexample to show that the delay independent global stability of DRDE can not guarantee the globally stable dynamics of the map. Finally, we apply the abstract results to the diffusive delay Nicholson blowfly equation and the diffusive Mackey-Glass' hematopoiesis equation. The resulting criteria for both model equations are amazingly simple and are optimal in some sense (no existing result to compare with for the latter though).