An International Conference
In Honor of Professor Shui-Nee Chow

New Directions In Dynamics of Evolution Equations

December 17-20, 2004

College of Mathematics and Econometrics

Hunan University

Changsha, Hunan

People's Republic of China

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Welcome Message

On behalf of the Organizing Committee, we are very pleased to welcome you to the international conference "New Directions In Dynamics of Evolution Equations". As you all have known, this conference is in honor of Professor Shui-Nee Chow, in the occasion of his 60th birthday, for his scientific achievements and leadership in dynamical systems and nonlinear analysis, as well as for his consistent support to Chinese mathematicians in these areas.

2. Schedule

Wednesday, December 17

Time	Speaker	Title/Activity
8:20-9:00am		**Opening**
9:00-9:40am	*G. Sell*	New developments in nonautonomous dynamics
9:40-10:20am	*K. Lu*	A "Mathematical" Puzzle
10:20-10:40am		**Coffee/Tea Break**
10:40-11:20am	*C. Li*	The cyclicity of the elliptic segment loops of reversible quadratic Hamiltonian systems under quadratic perturbations
11:20-12:00	*C. Cheng*	Variational construction of Arnold diffusion orbits
12:00-2:00pm		**Lunch**
2:00-2:40pm	*J. Muldowney*	Evolution of k-forms in dynamics
2:40-3:20pm	*J. Duan*	Stochastic Dynamics of Boundary Feedback Mechanism
3:20-4:00pm	*Y. Morita*	Entire Solutions to the Allen-Cahn Equation
4:00-4:20pm		**Coffee/Tea Breack**
4:20-5:00pm	*M. Zhang*	Twist Character of the Least Amplitude Periodic Solution of the Forced Pendulum
5:00-5:00pm	*W. Huang*	Spike Solutions for a Singularly Perturbed Differential Equation Modeling an Electrical Curcuit
6:00pm—		**Dinner**

Thursday, December 18

Time	Speaker	Title/Activity
8:20-9:00	*Y. Yi*	Invariant tori in Hamiltonian of one-and-a-half degree of freedom
9:00-9:40	*E. Yanagida*	Stability of Stationary Interfaces with Triple Junctions
9:40-10:20	*J. You*	Quasi-periodic Lyapunov Center Theorem and a Conjecture of M. Herman
10:20-10:40		**Coffee/Tea Break**
10:40-11:20	*D. Wang*	Unique Orbital normal form for vector fields of Hopf-zero singularities
11:20-12:00	*Y. Long*	Multiple brake orbits on convex symmetric domain in R^n
12:00-2:00		**Lunch**
2:00-2:40	1. *Y. Wang*	On the dynamics of all-recurrent rational maps
	2. *R. Yuan*	On almost periodic solution of logistic delay differential equations with almost periodic time dependence
2:40-3:20	1. *S. Zhang*	New Periodic Solutions of 3-Body Problems
	2. *D. Dai*	Galerkin analysis for Schrödinger equation
3:20-4:00	1. *Y. Huang*	Chaotic Behavior of Interval Maps and Total Variations of Iterates and Its Applications to PDE
	2. *D. Xu*	On asymptotic behavior of neural networks with delays, impulses or random parameters
4:00-4:10		**Coffee/Tea Breack**
4:10-4:50	1. *Y. Chen*	Multiple periodic solutions in a delayed periodic predator-prey system
	2. *J. Wei*	Stability and Bifurcation Analysis in a Neural Network Model with Time Delay
4:50-5:30	1. *X. Yuan*	Quasi-periodic solutions of completely resonant nonlinear wave equations
	2. *S. Zhou*	Kolmogorov Entropy Of Global Attractor For Dissipative Lattice Dynamical Systems
5:30-6:10	1. *S. Li*	Estimation of stability region of nonlinear dufferentional system with time delays
	2. *L. Wang*	Competition in Periodic Chemostat Models
6:30pm-		**Banquet**

Friday, December 19

Time	Speaker	Title/Activity
8:20-9:00am	*P. Bates*	Patterns and Waves for Nonlocal Bistable Equations with Indefinite Interaction
9:00-9:40am	*M. Han*	Existence of twelve small limit cycles in a cubic order plannar system
9:40-10:20am	*S. Ruan*	Stability of Steady States and Existence of Traveling Waves in a Vector Disease Model
10:20-10:40am		**Coffee/Tea Break**
10:40-11:20am	*Y. Nishiura*	Transient Dynamics of Particle-like Patterns in Dissipative Systems
11:20-12:00pm	*X. Wang*	Effect of diffusion and chemotaxis on population growth
12:00-2:00pm		**Lunch**
2:00-2:40pm	J. Yu	Applications of the Critical Point Theory to Discrete Hamilton Systems
2:40-3:20pm	*H. Zhu*	Cyclicity and bifurcation of degenerate graphics
3:20-4:00pm	*W. Chen*	Hypoellipticiy of Vector fields on Closed Manifold
4:00-4:20pm		**Coffee/Tea Breack**
4:20-5:00pm	*D. Zhu*	Homoclinic Bifurcation with Inclination Flips
5:00-5:40pm	*J. Jiang*	Smoothness of the Carrying Simplex for Discrete-time Competitive Dynamical Systems
6:00pm-		**Dinner**
8:00pm —		**Poster Session**

Saturday, December 20

Time	Speaker	Title/Activity
8:20-9:00am	*T. Krisztin*	Center Manifolds: Abstract FDEs, and FDEs with State-Dependent Delay
9:00-9:40am	*J. Wu*	Constructing Dynamical Systems for Identifying Patterns inside High Dimensional Data Sets
9:40-10:20am	*X. Ye*	On the classification of transitive systems
10:20-10:40am		**Coffee/Tea Break**
10:40-11:20am	*J. Li*	Bifurcations and smoothness of travelling wave solutions for some nonlinear wave equations
11:00-12:00pm	*X. Zou*	Long-time behavior of solutions to a discrete monostable reaction-diffusion equation with delay
12:00-2:00pm		**Lunch**
2:00-5:30pm		**Tour to the Yuelu Academy and Yuelu Hills**
6:00pm-		**Dinner**

4. Abstracts of Invited Talkes

(in alphabetical order of the **speakers**)

Patterns and Waves for Nonlocal Bistable Equations with Indefinite Interaction

Peter Bates
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Nonlocal interaction occurs in a wide variety of settings, from neuroscience to material science. I will describe some results concerning the equation $u_t = d(J * u - u) + f(u)$, where $d > 0$, f is bistable (e.g. $u - u^3$), with either $u \in \ell^\infty$ in the discrete case or $u \in L^\infty$ in the continuum, and $*$ is convolution, discrete or continuous. The kernel J may change sign but has unit integral. We give conditions under which stable stationary patterns exist and conditions under which traveling waves exist, even when $J(x)$ changes sign with x. Thus, the presence of both excitatory and inhibitory couplings can lead to pattern formation or homogeneity depending on finer details in the connections.

On the summability of the formal solutions for some PDEs with irregular singularity

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In this paper, we consider a kind of non -linear partial differential equations with regular singularity and irregular singularity with respect to $t = 0$ and $x = 0$ respectively. Our purpose is to establish the result similar to the k-summability known in the case of singular ordinary differential equations. It's shown that, under some conditions (e.g. the formal solution would be holomorphic to t), all formal solutions are Borel summable or k-summable with respect to x in all directions except at most a countable number set.

Hypoellipticiy of Vector fields on Closed Manifold

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In this talk we will discuss the relationship between hypoellipticity of vector felds, ergodic and Diophantine approximation.

Multiple periodic solutions in a delayed periodic predator-prey system

Yuming Chen
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In this talk, we consider a delayed periodic predator-prey system with a type IV functional response, which incorporates the periodicity of the fluctuating environment. Employing the continuation theorem, we obtain sufficient conditions for the existence of multiple periodic solutions. This is the first time that multiple periodic solutions are obtained by using the theory of coincidence degree.

Variational construction of Arnold diffusion orbits

Chongqing Cheng
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Under generic conditions, we show that Arnold diffusion orbits exist in priori-unstable Hamiltonian systems.

Galerkin analysis for Schrödinger equation

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We consider perturbed Schrödinger equation, which is an elliptic operator with unbounded coefficients. We use wavelets adapted to Schrödinger operator to deal with problems on unbounded domain. The wavelets are constructed from Hermite functions, which characterizes the space generated by the Schrödinger operator. We show that the Galerkin matrix can be pre-conditioned by a diagonal matrix so that its condition number is uniformly bounded. Moreover,we introduce a periodic pseudo-differential operator and show that its discrete Galerkin matrix under periodic wavelet system is equal to the Galerkin matrix for the equation with unbounded coefficients under the Hermite system. The convergence is proved in the L^2 topology.

Stochastic Dynamics of Boundary Feedback Mechanism

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Andrei Fursikov
Moscow State University

The authors consider stochastic aspects of the stabilization problem for two or three-dimensional Navier-Stokes equations with help of feedback control defined on a part of the boundary. Stochastic dynamical issues arise when inevitable unpredictable fluctuations in numerical realization of stabilization procedures are taken into account. The numerically realized solution to the stabilization problem is called a real process, which is modelled by a discrete random dynamical system (RDS). It is proved that this real process or random dynamical system can be stabilized via a boundary feedback control. Namely, under the boundary feedback control, the real process is ergodic with exponential mixing, in the sense of having a unique, exponentially attracting invariant measure. This implies that the unpredictable fluctuations in the numerical stabilization procedures can be controlled by this feedback mechanism.

Existence of twelve small limit cycles in a cubic order plannar system

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A cubic-order plannar system with symmetry in the origin is considered for the existence of small limit cycles. With the aid of normal form computation for degenerate Hopf bifurcations, it has been shown that it's possible for the cubic-order system to have twelve small limit cycles.

Spike Solutions for a Singularly Perturbed Differential Equation Modeling an Electrical Curcuit

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We consider a singularly perturbed system of differential equations with periodic forcing which is derived from an electrical circuit model. The system presents the spiking phenomena over a one time period that has important application in signal processing and in the technology in communication. In this research we are particularly interested in the number of cycles a solution completes in one time period (which pricisely produces the same number of spikes) and the stability of a spike's solution. Sophisticated mathematical analysis has been developed that enable us to give a complete identification of subregions $V_n,\ n = 1, 2, ...,$ in the parameter space such that in each V_n the system produce stable spike's solutions with pricisely n spikes.

Chaotic Behavior of Interval Maps and Total Variations of Iterates and Its Applications to PDE

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Interval maps reveal precious information about the chaotic behavior of general nonlinear systems. If an interval map $f: I \to I$ is chaotic, then its iterates f^n will display heightened oscillatory behavior or profiles as $n \to \infty$. This manifestation is quite intuitive and, here in this paper, is studied analytically in terms of the total variations of f^n on subintervals. These are three cases for the growth rates of the total variations of f^n as $n \to \infty$. The total variation of f^n grows unbounded (not necessarily exponentially) and exponentially on I, respectively and it grows unbounded on every subintervals of I. We study in detail these three cases in relations to the well known notions that describe the complexity of f.

As applications, we will consider the spatial rapid fluctuation of the one dimensional linear wave equations with composite nonlinear boundary conditions.

Smoothness of the Carrying Simplex for Discrete-time Competitive Dynamical Systems

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For the discrete-time dissipative competitive dynamical system on $\mathbb{R}^n_+$, the present authors [Uniqueness and attractivity of the carrying simplex for the discrete-time competitive dynamical systems, *J.D.E.*, 186(2002), 611-632] proved the existence of the carrying simplex. In this paper, the C^1 smoothness of the carrying simplex is investigated under the assumption, among others, that the system restricted on any face of $\mathbb{R}^n_+$ is permanent. Based on this, the amenable conditions are presented to guarantee the C^1 smoothness of the carrying simplex in the time-periodic competitive Kolmogorov systems of ODEs. We further provide a counterexample in time-periodic competitive Lotka-Volterra system showing that the carrying simplex need not to be C^1.

Center Manifolds: Abstract FDEs, and FDEs with State-Dependent Delay

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An explicite example (a 2-dimensional ODE) is constructed to show that a local center manifold of the time-1 map at a fixed point is not necessarily invariant with respect to the flow.

For a class of abstract FDEs smooth center, center-stable and center-unstable manifolds are given so that, first, these manifolds are obtained for a time-t map, and then their invariance is shown with respect to the semiflow.

The problem of existence of smooth center manifolds for state-dependent delay differential equations is also discussed.

The cyclicity of the elliptic segment loops of reversible quadratic Hamiltonian systems under quadratic perturbations

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We denote by Q_3^H and Q_3^R the Hamiltonian class and the reversible class of quadratic integrable systems. There are several topological types for systems belong to $Q_3^H \cap Q_3^R$. One of them is the case that the corresponding system has two heteroclinic loops, sharing one saddle–connection. This is called the elliptic segment loops. The paper by Chow, Li and Yi (2002 *Erg. Th.& Dyn. Syst.* **22**:349-374) studied the cyclicity of the period annuli, bounded by the elliptic segment loops. As usual, the conclusion does not apply to the loops. In the present work, we study the maximal number of limit cycles, which bifurcate from the loops under quadratic perturbations in reversible direction, and we prove this number is two. We also give the bifurcation diagram.

Bifurcations and smoothness of travelling wave solutions for some nonlinear wave equations

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By using the theory of bifurcations of dynamical systems to some nonlinear wave systems, the existence and smoothness of solitary, kink wave solutions and uncountably infinite many smooth and non-smooth periodic wave solutions are obtained. Unter different parametric conditions, various sufficient conditions to guarantee the existence of the above solutions are given. The talk gives a tutorial survey for our method and results.

Estimation of stability region of nonlinear dufferentional system with time delays

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This paper is devoted to the investigation of the stability region of some nonlinear differential systems with time delays. Results were obtained obtained to estimate the asymptotic stability region and exponential stability region using the properties of nonnegative matrices and techniques of inequalities.

Multiple brake orbits on convex symmetric domain in R^n

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In this talk, we announce a new joint result of Y. Long, D. Zhang, and C. Zhu on the existence of at least two brake orbits on any convex symmetric open bounded subset of R^n. This result gives a partial answer to a conjecture of H. Seifert proposed in 1948.

A "Mathematical" Puzzle

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Not available at his stage.

Entire Solutions to the Allen-Cahn Equation

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We consider the Allen-Cahn equation of one space dimension. It is well known that this equation allows traveling front wave with constant speed. One can also observe the annihilation and the diverging of two fronts from appropriate initial data. We show that there are two kind of entire solutions which characterize these behaviors respectively. One of them has the configuration such that the two fronts coming from the both sides of x-axis annihilate in a finite time while the other one emanating from an unstable equilibrium converges to the diverging fronts. We prove the existence of those entire solutions in terms of the comparison principle with appropriate supersolution and subsolution defined globally in negative time.

[1] Y. Fukao, Y. Morita, and H. Ninomiya, *Some entire solutions of the Allen-Cahn equation*, Taiwanese J. Math., in press.

[2] J. -S. Guo and Y. Morita, *Entire solutions of reaction-diffusion equations and an application to discrete diffusive equation*, to appear in Discrete Contin. Dynam. Systems

Evolution of k-forms in dynamics

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The study of the evolution of infinitesimal oriented k-dimensional volume elements in finite dimensional dynamical systems has provided many useful insights into questions such as the existence as omega limit sets of periodic orbits and other structures. It has also provided new approaches to questions such as the global stability of equilibria that have been found useful in applications. This talk will review the situation for finite dimensional systems, much of which was joint work with Michael Li. It will also report on joint work with Qian Wang towards an infinite dimensional theory.

Transient Dynamics of Particle-like Patterns in Dissipative Systems

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Transient dynamics has been discarded due to the nonexistence of good framework for mathematical description. On the other hand, most of thevivid and exotic dynamics contain many transitions from one state to another.For instance the well-established Turing patterns are very robust on a fixed domain, however a transition from one-stripe pattern to another becomes very subtle when the domain starts to grow. One of the reasons is that not only attractors but unstable objects play a crucial role to understand its subtleness. Firstly I will present a geometrical approach to this issue.Secondly a large deformation of pattern is frequently observed at a transition, especially when the pattern itself has a strong interaction with others, typically scattering among localized moving patterns. There are two types of strong interactions (or instabilities) for particle-like patterns, namely intrinsic and extrinsic ones. Self-replication and self-destruction are the typical examples of intrinsic type. Strong collision and the resulting scattering between traveling spots is of extrinsic one. Conventional perturbative methods don't work in this regime and there remain lots of open problems due to the large deformation of patterns not only in mathematical sense but also physical, biological or even computational sense. I will present several potentially useful vewpoints and tools to explore this fertile ground.

Stability of Steady States and Existence of Traveling Waves in a Vector Disease Model

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In this paper, a host-vector model is considered for a disease without immunity in which the current density of infectious vectors is related to the number of infectious hosts at earlier times. Spatial spread in a region is modeled in the partial integro-differential equation by a diffusion term. For the general model, we first study the stability of the steady states using the contracting convex sets technique. When the spatial variable is one-dimensional and the delay kernel assumes some special form, we establish the existence of traveling wave solutions by using the linear chain trick and the geometric singular perturbation method. (Based on a joint paper with Dongmei Xiao).

New developments in nonautonomous dynamics

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Not available at this stage.

Unique Orbital normal form for vector fields of Hopf-zero singularities

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Normal forms for vector fields of Hopf-zero singularity in R^3 are studied. Multiple Lie bracket method is used to give unique normal forms under both conjugacy and orbital equivalence for such vector fields with a generic quadratic part.

Competition in Periodic Chemostat Models

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In this talk, we investigate the competition of multiple species in in a periodic chemostat. Extinction results and uniform persistence of species are established in two cases: the resources are perfectly complementary and the resources are perfectly substitutable. Some ongoing work will be also introduced in this presentation.

Effect of diffusion and chemotaxis on population growth

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Consider a species of cells which diffuses randomly and is also chemotactic to a diffusive chemical. We study the effect of diffusion and chemotaxis of cells on their growth. At the steady state level, we show that diffusion is detrimental and chemotaxis is beneficial to the growth. Then we consider the case when two species of cells compete for the same chemical. Our results(joint work with Yaping Wu) give a diagram in terms of diffusion coefficients and chemotaxis coefficients, for stable co-existence and competition-exclusion.

On the dynamics of all-recurrent rational maps

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We will talk about recent results on the Topological presures and Hausdorff dimensions of the Julia sets of all-recurrent rational maps.

Stability and Bifurcation Analysis in a Neural Network Model with Time Delay

Junjie Wei
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A two-neuron network model with self-connection and delays is considered. Linear stability of the model is investigated. It is found that there are a Bogdanov-Takens singularity for any time delay, and pitchfork and Hopf bifurcation co-existence. The bifurcation diagram is drawn in the parameter space.

Constructing Dynamical Systems for Identifying Patterns inside High Dimensional Data Sets

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We provide some recent work for pattern recognition in high dimensional data sets. The work is based on a noval neural network architecture and a new delay differential system with adaptive delays, and the work also suggests an inverse problem of invariant manifolds theory for high dimensional dydnamical systems.

On asymptotic behavior of neural networks with delays, impulses or random parameters

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The asymptotic behavior of a general class of neural networks with delays, impulses or random parameters is investigated. Some new sufficient conditions ensuring the existence, uniqueness, and stability of the periodic solution or equilibrium are established for these networks, respectively. These conditions are less restrictive than previously known criteria and can be easily verified. Therefore, our results have important significance in the design of neural circuits. The existence results for the equilibrium are given by deriving the following lemma.

Lemma. Assume that the operator $h : \bar{U} \subset X \to R^n$ is compact on the closure of the nonempty bounded open set U in the Banach space X. Let $0 \in U$ and ∂U is the boundary of U. If there is an i such that $h_i(u)sgnu_i > 0$, $\mathcal{F}orallu \in \partial U$. Then the equation $h(u) = 0$ has a solution u on $\bar{U}$.

Stability of Stationary Interfaces with Triple Junctions

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We consider the curvature-driven motion of interfaces on a bounded domain that contacts with the boundary at the right angle and has triple junctions with prescribed angles. We derive a linearized system at a stationary interface, and obtain a characteristic function whose zeros correspond to the eigenvalues of the linearized operator. From the characteristic function, it is shown that the unstable dimension depends mainly on the curvature of the boundary, but not so much on the shape of the stationary interface.

On the classification of transitive systems

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Not available at this stage.

Invariant tori in Hamiltonian of one-and-a-half degree of freedom

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This talk is about two-quasi-periodicity in a large class of one-and-a-half degree of freedom Hamiltonian systems, that depend periodically on time. The main result is that such systems have Aubry-Mather sets corresponding to any internal frequency larger than an explicitly given bound. If moreover this frequency is of constant type (relative to the forcing frequency), then the Aubry-Mather set is an invariant torus. We stress that the system is not required to be a small perturbation of an integrable one.

Quasi-periodic Lyapunov Center Theorem and a Conjecture of M. Herman

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In this talk, we will present a quasi-periodic version of Lyapunov centIn this talk, we will present a quasi-periodic version of Lyapunov center theorem. As a special case, the result gives an answer to a conjecture of M.Herman on the existence of Lagrangian tori in the neighborhood of elliptic equilibriums. er theorem. As a special case, the result gives an answer to a conjecture of M.Herman on the existence of Lagrangian tori in the neighborhood of elliptic equilibriums.

Applications of the Critical Point Theory to Discrete Hamilton Systems

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This paper deals with the existence and multiplicity of periodic solutions, subharmonic solutions and solutions of boundary value problems by using critical point theory for the discrete Hamiltonian systems. The following discrete systems are studied

$$\Delta^2 x_{n-1} + f(n, x_n) = 0, n \in \mathbf{Z}, \tag{0.1}$$

$$\begin{cases} \Delta x_1(n) = -H_{x_2}(n, x_1(n+1), x_2(n)) \\ \Delta x_2(n) = H_{x_1}(n, x_1(n+1), x_2(n)) \end{cases}, \tag{0.2}$$

$$\triangle[p(t) \triangle u(t-1)] + q(t)u(t) = f(t, u(t)). \tag{0.3}$$

Some new results are obtained. To the best knowledge of the author, this is the first time to deal with the existence and multiplicity problems of discrete systems by critical point theory. Therefore, the present paper provides a new approach to study discrete systems.

On almost periodic solution of logistic delay differential equations with almost periodic time dependence

Rong Yuan
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In this talk, we discuss the almost periodic logistic delay differential equations and explain the module of its almost periodic solution. We find an important property, which is different from that given by Cartwright for Ordinary Differential Equations (ODE). A new class of quasi-periodic functions is detailed. The present result is basically a complete extension of the known results for almost periodic logistic delay differential equations.

Quasi-periodic solutions of completely resonant nonlinear wave equations

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When the potential $V \neq 0$, the existence of the quasi-periodic solutions of the nonlinear wave equations (NLW)

$$u_{tt} - u_{xx} + V(x)u \pm u^3 = 0, \quad x \in S^1,$$

is investigated by many authors, such as Kuksin, Wayne, Pöschel and Bourgain. When $V \equiv 0$, is there any quasi-periodic solution of the NLW? This is an open problem. See [Kuksin, 1998's ICM], [Pöschle, Comm. Math. Hel. 71, 1996], for example.

In this paper, we show that there are many of quasi-periodic solutions of NLW when $V \equiv 0$.

Twist Character of the Least Amplitude Periodic Solution of the Forced Pendulum

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We will develop some twist criteria for the periodic solution of a periodic scalar Newtonian equation using the third order approximation. These criteria cover the cases of higher order linearly stable linearization equations. Applications are given to the least amplitude periodic solution of the forced pendulum. After excluding the resonances up to order 3, some quantative estimates will be given.

New Periodic Solutions of 3-Body Problems

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Using variational methods,we prove the existence of some new periodic solutions for 3-body problems.

Kolmogorov Entropy Of Global Attractor For Dissipative Lattice Dynamical Systems

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We consider the Kolmogorov's ε-entropy of the global attractor for first order dissipative lattice dynamical systems. By element decomposition and the covering property of a polyhedron by balls of radii ε in the finite dimensional space, we obtain an estimate of the upper bound for the Kolmogorov's ε-entropy of the global attractor

Homoclinic Bifurcation with Inclination Flips

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The bifurcation problems of homoclinic orbit with orbit flips and inclination flips are introduced. Then the homoclinic bifurcations in four dimensional vector fields are investigated.. The homoclinic orbit is principal but its stable and unstable foliations take inclination flip. The existence, nonexistence, and uniqueness of the 1-homoclinic orbit and 1- periodic orbit are studied. The existence of the two-fold 1-periodic orbit and three-fold 1-periodic orbit are also obtained. It is also revealed that the number of periodic orbits bifurcated from this kind of homoclinic orbits depends heavily on their strength of the inclination flip.

Cyclicity and bifurcation of degenerate graphics

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A graphic (singular cycle, limit periodic set, polycycle) of a planar vector field is an invariant set of the vector field involving regular orbits and singular points.The degenerate graphics are the graphics with a nilpotent singular point or a line (curve)of singular points. The question of finding the number of limit cycles which appear by perturbation of a graphic in a generic family and the problem of finite cyclicity is closely related to Hilbert-Arnold Problem and Hilbert's 16th problem. I will talk about the finite cyclicity of the degenerate graphics and their bifurcations. As an application, I will also discuss the two periodic solutions of a predator-prey system which cannot be explained by the existing bifurcation theory.

Long-time behavior of solutions to a discrete monostable reaction-diffusion equation with delay

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In this talk, we discuss traveling wavefronts of the following system of lattice differential equations

$$u_n(t) = D[u_{n+1}(t) + u_{n-1}(t) - 2u_n(t)] - du_n(t) + b(u_n(t-r)),$$

where $n \in Z$, $t > 0$, $D, d > 0$, $r \geq 0$, $b \in C^1(R)$ and $b(0) = dK - b(K) = 0$ for some $K > 0$. In the monostable case, we show that there exists a minimal wave speed $c^* > 0$, such that for each $c > c^*$ the equation has *exactly one* traveling wavefront $u_n(t) = U(n + ct)$ (up to a translation) satisfying $U(-\infty) = 0, U(+\infty) = K$; and this wave front is asymptotically stable in some reasonbale sens. We also discuss the asymptotic speed of propogation for this system.

4. Abstracts for the Poster Session

Mixing and proximal cells along sequences

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A dynamical system (X,T) is $\mathcal{F}$-transitive if for each pair of open and non-empty subsets U and V of X, $N(U,V)=\{n\in\mathcal{Z}_+ : U\cap T^{-n}V\neq\emptyset\}\in\mathcal{F}$, where $\mathcal{F}$ is a collection of subsets of $\mathcal{Z}_+$ which is hereditary upward. (X,T) is $\mathcal{F}$-mixing if $(X\times X, T\times T)$ is $\mathcal{F}$-transitive. For a subset S of $\mathcal{Z}_+$, $(x,y)\in X\times X$ is S-proximal if $\mathcal{D}size\liminf_{S\ni n\to+\infty} d(T^n(x),T^n(y))=0$ and the S-proximal cell $P_S(x)$ is the set of points which are S-proximal to $x\in X$. We show that if (X,T) is $\mathcal{F}$-mixing then for each $S\in k\mathcal{F}$ (the dual family of $\mathcal{F}$) and $x\in X$, $P_S(x)$ is a dense $G_{\mathcal{D}elta}$ subset of X, and when (X,T) is minimal and $\mathcal{F}$ is a filter the reciprocal is true. Moreover, other conditions under which the reciprocal is true are obtained. Finally the structure of proximal cells for $\mathcal{F}$- mixing systems is discussed, and a new and simpler proof of the Xiong-Yang's theorem is presented.

Stability and bifurcation analysis in van der Pol's oscillator with delayed feedback

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The classical van der Pol equation with delayed feedback and a modified equation where a delayed term provides the damping are considered. Linear stability of the equations is investigated by analyzing the associated characteristic equations. It is found that there exist the stability switches when delay varies, and the Hopf bifurcation occurs when the delay passes through a sequence of critical values. The bifurcation diagram is drawn in (ε,k)-plane, and the stability and direction of the Hopf bifurcation are determined by applying the normal form theory and the center manifold theorem.

Global Asymptotic Stability of a Nonlinear Recursive Sequence

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A sufficient condition is obtained to guarantee the global asymptotic stability of the following nonlinear recursive difference equation

$$x_{n+1} = \frac{x_n x_{n-1}^b + x_{n-2}^b + a}{x_{n-1}^b + x_n x_{n-2}^b + a}, \quad n = 0, 1, 2, \cdots,$$

where $a, b \in [0, \infty)$ and the initial values $x_{-2}, x_{-1}, x_0 \in (0, \infty)$. Some known results are included and improved.

Entropy characterization of mixing

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In this paper we investigate systemically several kinds of mixing via sequence entropy in ergodic theory and topological dynamics. We show that If $(X, \mathcal{B}, \mu, T)$ is an invertible measure preserving system, then $(X, \mathcal{B}, \mu, T)$ is weakly mixing(resp. mildly mixing) if and only if for any finite non-trivial partition α of X and $F \in \mathcal{D}^*$(resp. IP-set F), there exists an infinite sequence $A \subseteq F$ such that $h_\mu^A(T, \alpha) > 0$; if $(X, \mathcal{B}, \mu, T)$ is strongly mixing then for any finite non-trivial partition α of X and any infinite set F of $\mathcal{Z}_+$, there exists an infinite sequence $A \subseteq F$ such that $h_\mu^A(T, \alpha) > 0$, but the converse is not true. In topological case we show that if (X, T) is a topologically dynamical system, then (X, T) is topologically weakly mixing (resp. topologically mildly mixing) if and only if for each topological non-trivial finite open cover $\mathcal{U}$ and confinte subset F (resp. IP-set F) there exists an infinite sequence $A \subseteq F$ such that $h_{\text{top}}^A(T, \mathcal{U}) > 0$; if (X, T) is strongly mixing, then for each topological non-trivial finite open cover $\mathcal{U}$ and infinite set F, there exists an infinite sequence $A \subseteq F$ such that $h_{\text{top}}^A(T, \mathcal{U}) > 0$, but the converse does not hold. And by building the relations between entropy pair and IP-sequence entropy, we also prove that any transitive diagonal flow is mildly mixing.