First International Conference on
Recent Advances in Bifurcation Theory
and Applications of Dynamical Systems

June 8-12, 2005
JINHUA, Zhejiang Province, P. R. CHINA

Abstracts of Invited and Contributed Lectures

Center for Dynamical Systems and Nonlinear Studies, Zhejiang Normal University, PRC
College of Mathematics and Physics, Zhejiang Normal University, PRC

June 2005

Scientific Committee

Shui-Nee Chow, Chair (Georgia Institute of Technology, USA)
Peter W. Bates, Co-Chair (Michigan State University, USA)
Guanrong Chen (City University of Hong Kong, Hong Kong)
L.O. Chua (University of California at Berkeley, USA)
Boling Guo (Institute of Applied Physics and Computational Math., Beijing, PRC)
Zhujun Jing (Hunan Normal University, Changsha, PRC)
Chengzhi Li (Beijing University, Beijing, PRC)
Zengrong Liu (Shanghai University, Shanghai, PRC)
Kening Lu (Michigan State University and Brigham Young University, USA)
Zhien Ma (Xian Jiaotong University,Xian, PRC)
Jiong Ruan (Fudan University, Shanghai, PRC)
Dana Schlomiuk (Montreal University, Canada)
Yuefei Wang (Institute of Math. and System Science, Chinese Academy of Sciences, PRC)
Jianhong Wu (York University, Canada)
Zhihong Xia (Northwest University, USA)
Deming Zhu (Normal University of East China, Shanghai, PRC)

Sponsors

National Natural Science Foundation of China (NSFC);
Zhejiang Normal University, PRC.

Local Organizing Committee

Hui Xu, Honorary Chair (President of Zhejiang Normal University, PRC)
Fangyue Chen, Chair (Dean of College of Math. and Phys., Zhejiang Normal University, PRC)
Jibin Li, Co-Chair (Zhejiang Normal University and KUST, PRC)
Xinchu Fu (Shanghai University, PRC)
Wenxian Shen (Auburn University, USA)
Xiaohua Zhao (Zhejiang Normal University, PRC)

Layered and Spiked Solutions for Nonlinear Equations

Shangbin Ai
University of Alabama at Huntsville, USA

We study the Neumann boundary value problem $\varepsilon^2 u_{xx} = f(x,u) = Au(u-\phi)(u-1)$, $u_x(0) = u_x(1) = 0$, where $A = A(x,u) > 0$, $\phi = \phi(x) \in (0,1)$, and $\varepsilon > 0$ is sufficiently small. We are interested in the solutions of the problem with an ε independent number of oscillations (around ϕ). Such solutions exhibit layers and spikes. We will talk about a recent result (jointed with Xinfu Chen and Stuart Hastings) on these solutions, including their existence (with complicated patterns of layers and spikes), the locations of their layers and spikes, and their Morse indices.

Computation using networks of cluster synchronized states

Peter Ashwin
Department of Mathematical Sciences
University of Exeter
Exeter EX4 4QE, UK

In globally coupled oscillator systems one can find robust dynamics that consists only of saddle periodic orbits connected by heteroclinic connections. This presentation will discuss some aspects of this dynamics and how it may be relevant as a simple model for several aspects of neural systems.

Qualitative Analysis for two Central Symmetric Cubic Systems

Sang Bo
Department of Mathematics
Zhongshan University
Guangzhou 510275
P. R. CHINA

Based on Grobner base method, we bring in a Maple 9.5 package for computing and simplification of two kinds of focal quantities. By using the package, we investigate three centers coexistence for a central symmetric cubic system, and study the center-focus problem and multiple Hopf bifurcations for another central symmetric cubic system.

Key words: focus-center problem,focal quanties, limit cycle,multiple Hopf bifurcations.

Subadditive topological pressure and its application in dimension theory

Yongluo Cao
Department of Mathematics
Suzhou University
Suzhou 215006, Jiangsu, P.R.China
E-mail: ylcaosuda.edu.cn, yongluocaoyahoo.com

In this talk, we give a definition of subadditive topological pressure and prove the corresponding variational principal. Furthermore, we obtain the estimate of Hausdorff dimension of repeller in dynamical systems using subadditive topological pressure.

Realization and bifurcation of boolean functions via cellular neural networks

Fangyue Chen[a] and Guanrong Chen [b]
a. Department of Mathematics, Zhejiang Normal University
Jinhua 321004 CHINA email: fychen@zjnu.cn
b. Department of Electronic Engineering, City University of Hong Kong, CHINA
(gchen@ee.cityu.edu.hk)

In this work, we study the realization and bifurcation of Boolean functions of four variables via a Cellular Neural Network (CNN).We characterize the basic relations between the genes and the offsets of an uncoupled CNN as well as the basis of the binary input vectors set. Based on the analysis, we have rigorously proved that there are exactly 1882 linearly separable Boolean functions of four variables, and found an effective method for realizing all linearly separable Boolean functions via an uncoupled CNN. Consequently, any kind of linearly separable Boolean function can be implemented by an uncoupled CNN, and all CNN genes that are associated with these Boolean functions, called the CNN gene bank of four variables, can be easily determined. Through this work, we will show that the standard CNN invented by Chua and Yang in 1988 indeed is very essential not only in terms of engineering applications but also in the sense of fundamental mathematics.

Traveling waves for system of nonlocal evolution equations

Fengxin Chen
University of Texas at San Antonio
E-mail: feng@lonestar.utsa.edu

The main concern of this talk is the existence, uniqueness and stablity of traveling waves for system of nonlocal evolution equations with monotone nonlinearity. The spectral analysis is also studied.

Center conditions and bifurcation of limit cycles at degenerate singular points in a quintic polynomial differential system [1]

Haibo Chen[a,b,*], Yirong Liu[b], Xianwu Zeng[a]
[a]Mathematics and statistics school of Wuhan University, Wuhan, 430072, China
[b]Mathematics school of Central South University, Changsha, 410075,China

The center problem and Bifurcation of limit cycles for degenerate singular points are far to be solved in general. In this paper, we study center conditions and bifurcation of limit cycles at the degenerate singular point in a class of quintic polynomial vector field with a small parameter and eight normal parameters. We deduce a recursion formula for singular point quantities at the degenerate singular points in this system and reach with relative ease an expression of the first five quantities at the degenerate singular point. The center conditions for the degenerate singular point of this system are derived. Consequently, we construct a quintic system, which can bifurcates 5 limit cycles in the neighborhood of the degenerate singular point. The positions of these limit cycles can be pointed out exactly without constructing Poincaré cycle fields. The technique employed in this work is essentially different from more usual ones. The recursion formula we present in this paper for the calculation of singular point quantities at degenerate singular point is linear and then avoids complex integrating operations.
AMS classification: 34A05; 34C05
Key words: Limit cycles; Degenerate singular point; Quintic differential system

Principal parametric resonance of axially accelerating viscoelastic strings with an integral constitutive law

Li-Qun Chen
Department of Mechanics
Shanghai University
Shanghai 200444, P. R. China
Shanghai Institute of Applied Mathematics and Mechanics
Shanghai 200072, P. R. China

The steady-state transverse responses and the stability of an axially accelerating viscoelastic string are investigated. The governing equation is derived from the Eulerian equation of motion of a continuum, which leads to the Mote model for transverse motion. The Kirchhoff model is derived from the Mote model by replacing the tension with the averaged tension over the string. The method of multiple scales is applied to the two models in the case of principal parametric resonance. Closed-form expressions of the amplitudes and the existence conditions of steady-state periodical responses are presented. The Lyapunov linearized stability theory is employed to demonstrate that the first (second) nontrivial steady-state response is always stable (unstable). Numerical calculations show that the two models are qualitatively the same, but quantitatively different. Numerical results are also presented to highlight the effects the mean axial speed, the axial speed fluctuation amplitude, and the viscoelastic parameters.

[1]Corresponding author. E-mail address: math_chb@mail.csu.edu.cn

Dynamics of a Network of Three Neurons with Delayed Coupling

Yuming Chen
Department of Mathematics
Wilfrid Laurier University
Waterloo ON N2L 3C5, Canada

Consider

$$\dot{x}_i(t) = -x_i(t) + ah(x_i(t-\tau)) + b[g(x_{i-1}(t-\tau)) + g(x_{i+1}(t-\tau)) - 2g(x_i(t-\tau))],$$

where i (mod 3) and h and g are sigmoidal functions. The system models the evolution of a neural network of three identical neurons. First, we study the existence and stability of equilibria, Hopf bifurcation. Then a discrete Lyapunov functional is introduced to give a Morse decomposition of the global attractor. This is a joint work with J. Wu.

An analysis of Phase Noise in Nonlinear Oscillators

Shui-Nee Chow
Georgia Institute of Technology, USA
E-mail: chow@math.gatech.edu

Positive Periodic Solutions of Coupled Delay Difference Systems Depending on Two Parameters [2]

Na Zhang [a] , Binxiang Dai [b,3] and Xiangzhen Qian [a]
[a] College of Mathematics and Econometrics, Hunan University,Changsha, Hunan 410082, China
[b] School of Mathematical Science and Computing Technology, Central South University, Changsha, Hunan 410075, China

In this paper, we investigate a coupled delay difference system depending on two parameters:

$$\begin{aligned} x(n+1) &= a(n)x(n) + \lambda p(n) f(x(n-\tau_1(n)), y(n-\sigma_1(n))), \\ y(n+1) &= b(n)y(n) + \mu q(n) g(x(n-\tau_2(n)), y(n-\sigma_2(n))). \end{aligned}$$

It is shown that the number of the positive periodic solutions of the system can be determined by the asymptotic behavior of the quotient of $\frac{f(x,y)}{x+y}, \frac{g(x,y)}{x+y}$ at $(0,0)$ and (∞,∞). our arguments are based on a well-known fixed index theory.

[2]Research partially supported by Hunan Province Natural Science Foundation(02JJY2012) and Natural Science Foundation of Central South University.
[3]Corresponding author. E-mail address: bxdai@hnu.cn

Singular Dynamics with Application to Singular Waves in Physical Problems

Hui-Hui Dai, Debin Huang[b] and Zengrong Liu[b]
Department of Mathematics, City University Of Hong Kong, Kowloon, Hong Kong. E-mail: mahhdai@cityu.edu.hk
[b] Department of Mathematics, Shanghai University, Shanghai 200444, P. R. China

Many physical problems are governed by certain systems of singular ordinary differential equations (ODEs). As a result, singular solutions can arise. In this paper, we provide some theoretical results to deal with these solutions. By applying straightforwardly the notion of weak solutions for partial differential equations (PDEs), a notion of weak solutions for this ODE type is proposed to include these singular solutions. As an application, we consider some traveling-wave solutions of a nonlinear dispersion equation arising in a physical problem. It is shown that compactons can arise in nonlinear elastic rods.
Keywords: Singular waves, singular dynamics, compactons

Collective motion - how the Dd slug moves

John Dallon
Brigham Young University
USA

In this talk I will discuss a model of cell-cell force interactions. In the Dictyostelium discoideum slug, experimental results and theory seem to contradict each other. The model siulations allow us to investigate questions ab out how the Dd slug generates forces and moves, thereby giving plausible explanations for the apparent contradictions.

Singular Perturbations for Third-Order Nonlinear Multi-point Boundary Value Problem

Zengji Du[a] Weigao Ge[a] Mingru Zhou[b]
a. Department of Mathematics, Beijing Institute of Technology, Beijing 100081
b. Department of Mathematics, Xuzhou Normal University, Xuzhou, Jiangsu, 221116
E-mail address: duzengji@163.com

This paper first discuss the existence of the third-order multi-point boundary value problem (BVP, for short)

$$\begin{aligned}&x'''(t) + f(t, x(t), x'(t), x''(t)) = 0, \quad 0 \le t \le 1,\\&x(0) = 0,\\&ax'(0) - bx''(0) + \textstyle\sum_{i=1}^{n-2} \alpha_i x(\xi_i) = A,\\&cx'(1) + dx''(1) + \textstyle\sum_{i=1}^{n-2} \beta_i x(\eta_i) = B;\end{aligned}$$

where $a, b, c, d \ge 0, A, B \in R, a + b > 0, c + d > 0, \alpha_i \le 0, \beta_i \le 0$, $i = 1, 2, \cdots, n-2$, $0 < \xi_1 < \xi_2 < \cdots < \xi_{n-2} < 1$, and $0 < \eta_1 < \eta_2 < \cdots < \eta_{n-2} < 1$.

And then we study the following third-order multi-point singularly perturbed BVP

$$\begin{array}{l} \varepsilon x'''(t) + f(t, x(t), x'(t), x''(t), \varepsilon) = 0, \quad 0 \le t \le 1,\ 0 < \varepsilon \ll 1, \\ x(0, \varepsilon) = 0, \\ ax'(0, \varepsilon) - bx''(0, \varepsilon) + \sum_{i=1}^{n-2} \alpha_i x(\xi_i, \varepsilon) = A, \\ cx'(1, \varepsilon) + dx''(1, \varepsilon) + \sum_{i=1}^{n-2} \beta_i x(\eta_i, \varepsilon) = B, \end{array}$$

The existence, uniqueness and asymptotic estimates of solutions of the singularly perturbed boundary value problem are give by using priori estimates, differential inequalities technique and Leray-Schauder degree theory.

Invariant manifolds and model reduction for stochastic systems

Jinqiao Duan
Department of Applied Mathematics
Illinois Institute of Technology
Chicago, IL 60616, USA

Randomness or uncertainty is ubiquitous in scientific and engineering systems. Taking stochastic effects into account is of central importance for the development of mathematical models of nonlinear phenomena under random influences.

Invariant manifolds, especially stable and unstable manifolds, provide geometric structures for understanding dynamical behavior, and for macroscopic description or model reduction of nonlinear random systems. The speaker will present rcent work in this area.

Bifurcation, Intermittency, Chaosand Dynamical Synchronization in Complex Networks

Jinqing Fang
China Institute of Atomic Energy
P. O. Box 275-81
Beijing 102413
P. R. China
E-mail: fjq96@iris.ciae.ac.cn

In recent years, the study of complex networks has attracted much attention since the small world (SW) networks and the scale-free networks (SF) have been discovered in 1998 and 1999 respectively. Nonlinear networks with SW or SF have been often used to model many real-world networks from physics to technology, biology to society. Some investigations have shown that such nonlinear networks can exhibit some new dynamical behaviors, such as array of identical nonlinear oscillations often synchronize, may change or eliminate bifurcation, and form new patterns, which depend on what type of networks is and the symmetry of the underlying network and so on. In this talk, we provide a brief overview on this subject and give some our research results as well, including synchronization and control of dynamical behavior in complex networks.

Key words: Complex networks, scale-free, small world, nonlinear dynamics, bifurcation, chaos, synchronization behaviors

Noise-induced chaos in the quadratically nonlinear oscillator

Chunbiao Gan
Department of Mechanics, CMEE, Zhejiang University
Hangzhou, 310027, P. R. China.
E-mail: cb-gan@zju.edu.cn

Engineering structures are often subjected to time dependent loadings of both deterministic and stochastic nature, such as those occurring due to wind gusts, earthquakes, and ocean waves. Therefore, in the study of dynamics of engineering structures, the existence of noise as an external perturbation cannot be ruled out.

In 1990s, noise-induced chaos was studied theoretically by the stochastic Melnikov method [1]. The maximum Lyapunov exponent can be used to quantify the noise-induced chaos response. Till now, most authors employed the algorithm for the Lyapunov exponent presented by Wolf et al [2] even for a stochastic dynamic system. As pointed out by Kantz et al [3], the algorithm by Wolf is not very robust and one can easily obtain the wrong results. While Wolf's algorithm only uses a delay reconstruction of phase space, there is another class of algorithms which also involves the approximation of the underlying deterministic dynamics [4]. The output data are generally affected by noise, its influence can be minimized by using the averaging statistics when computing the exponent by the latter algorithm.

The purpose of this paper is to discuss the noise-induced chaos in the quadratically nonlinear oscillator. The Melnikov approach is used to obtain the necessary conditions for the rising of chaos, and the largest Lyapunov exponent is shown to identify the chaotic nature for every sample time series of the system. It is shown that the external Gaussian white noise excitation is robust for the rising of chaos, while the external bounded noise is not. Mostly importantly, it is found that noise excitation can induce chaos by the necessary Melnikov condition and the simulation of the largest Lyapunov exponent.

References

[1] M Frey and E Simiu, Noise-induced chaos and phase space flux, Physical D, 63: 321-340, 1993

[2] H Kantz and T Schreiber, Nonlinear Time Series Analysis, Cambridge University Press, Cambridge, England, 1997

[3] A Wolf, J R Swift, H L Swinney and J A Vastano, Determining Lyapunov exponents from a time series, Physical D, 16: 285-317, 1985

[4] M T Rosenstein, J J Collins and C J De Luca, A practical method for calculating largest Lyapunov exponents from small data sets. Physical D, 65: 117-134, 1993

Rain-Flow Count Method in Fatigue Damage under Wide Band Random Excitation

Shimin He[a] Chunbiao Gan[b]
a. College of Mechanical and Energy Engineering, Zhejiang University
Hangzhou,310027, P. R. China. Email: hsm@cmee.zju.edu.cn

b. Department of Mechanics, CMEE, Zhejiang University
Hangzhou, 310027, P. R. China. Email: cb _ gan@zju.edu.cn

The process of fatigue damage is usually considered to be a diffusive and slow-variant Markov process in comparison with stochastic stress process, and its transferring probability density can be obtained by solving the corresponding FPK equation. Further, the statistic value of fatigue damage and fatigue life, such as the conditional mean value and the variance of fatigue damage, the reliability function of fatigue, the conditional probability density of fatigue life, the mean value and the variance of fatigue life and so on, can also be known.

The difficulty on solving the FPK equation mainly lies in how to get the one- dimensional or the joint probability density of process of stress peak. When the stress process is a stationary narrow-band stochastic process, the one-dimensional probability density and the approximate joint probability density exist and the corresponding FPK equation can be solved directly. However, the analytical expression of statistical characteristic of stress peak doesn't exist if the stress process is a stationary wide-band stochastic process, and in this case, the FPK equation is insolvable.

In this paper, the authors show that the rain-flow count method can be used in obtaining the one-dimensional probability density and the joint probability density of the stationary wide-band stress process, and the FPK equation can also be solved by employing this method, from which one can get the statistic characteristics of fatigue damage and fatigue life.

References

[1] W Q Zhu and M X Jiang, Nonlinear Fatigue Damage Accumulation Under Random Loading. Journal of Pressure Technology, 118: 168-173, 1996

[2] W Q Zhu and Y Lei, A stochastic theory of cumulative fatigue damage. The 2nd International Conference on Stochastic Structural Dynamics, Boca Raton, Florida, 1990

[3] P H Wirsching, A M ASME and M C Light, Fatigue under wide band random stress. Journal of the Structural Division, 124: 1593-1607, 1980

[4] P H Wirsching and A M Shehata, Fatigue under wide band random stresses using the rain flow method. Journal of the Engineering Materials and Technology, 99(3): 205-211, 1977

Generalized Polar Coordinates and Poincaré-Birkhoff Twist Fixed Point Theorem

Weigao Ge and Youyu Wang
Department of Mathematics
Beijing Institute of Technology
Beijing 100081, China

In this paper we extend the Poincaré-Birkhoff theorem in two directions. One is to remove the requirement that the inner boundary of A_0 is stellar shaped and the other is the use of generalized polar coordinates in the definition of the lifting F of mapping f. Our proof does not depend upon previous results.

Theorem 1 *Let $T : A \subset R^2\backslash\{0\} \to T(A) \subset R^2\backslash\{0\}$ be an area-preserving homeomorphism with $T(C_2)$ out of $T(C_1)$. Suppose T has a lifting $\widetilde{T}$ defined by $(r,\theta) \mapsto (r^*,\theta^*) = (f(r,\theta), \theta+2m\pi+g(r,\theta))$ where $f,\ g : P^{-1}(A) \to R$ are continuous and 2π-periodic in θ. If i) $g(r,\theta) \le 0$ (≥ 0) for $(r,\theta) \in C_1$ and $g(r,\theta) \ge 0$ (≤ 0) for $(r,\theta) \in C_2$; ii) areaD_1=area$\hat{D}_1$. Then $\widetilde{T}$ has at least two fixed points (r_1,θ_1) and (r_2,θ_2) with $\theta_1 \neq \theta_2 (\mathrm{mod}\ 2\pi)$ and therefore T has two different fixed points $P(r_1,\theta_1)$ and $P(r_2,\theta_2)$ in A.*

Theorem 2 *Let $T : A \subset R^2\backslash\{0\} \to R^2\backslash\{0\}$ be an area-preserving homeomorphism with $T(C_2)$ out of $T(C_1) = C_1$. Suppose T has a lifting $\widetilde{T}$ defined by $(r,\theta) \mapsto (f(r,\theta), \theta + 2m\pi + g(r,\theta))$ where $f,\ g : P^{-1}(A) \to H$ are continuous in (r,θ) and 2π-periodic in θ, m is an integer. If there is $(r_0,\theta_0) \in C_1$ such that $g(r_0,\theta_0) < 0$ (> 0) and*

$$g(r,\theta) \ge 0 \quad (\le 0) \quad \textit{holds for each } (r,\theta) \in C_2 \tag{1}$$

then T has at least two different fixed points in A. Furthermore, if strict inequality holds in (1), then at least one fixed points is in int$A$.

Theorem 3 *Let $T : A \subset R^2\backslash\{0\} \to R^2\backslash\{0\}$ be an area-preserving homeomorphism with $T(C_2) = C_2$ out of $T(C_1)$. Suppose T has a lifting $\widetilde{T}$ defined by*

$$T : (r,\theta) \mapsto (f(r,\theta), \theta + 2m\pi + g(r,\theta))$$

where $f,\ g : P^{-1}(A) \to H$ are continuous in (r,θ) and 2π-periodic in θ, m is an integer.

If there is $(\bar{r},\bar{\theta}) \in P^{-1}(C_2)$ such that $g(\bar{r},\bar{\theta}) > 0$ (< 0) and

$$g(r,\theta) \le 0 \quad (\ge 0) \quad \textit{holds for each } (r,\theta) \in C_1 \tag{2}$$

then T has at least two different fixed points in A. In addition, if strict inequality holds in (2), then at least one fixed points is in int$A$.

Macroscopic and microscopic dynamics of two dimensional piecewise isometries

Arek Goetz
San Francisco State University
Department of Mathematics
goetz@sfsu.edu
http://dynamics.sfsu.edu/goetz/

In this talk we illustrate the dynamics of maps whose restrictions to domains are Euclidean isometries. These maps while they generalize one dimensional counterparts called interval exchange transformations, their landscape of phenomena, in contrast to interval exchanges, is highly nonergodic and sometimes geometrically fractal. In this talk we discuss and show examples that illustrate the complexity of these maps. We also discuss available tools for studying rational piecewise isometries.

Hopf bifurcation analysis of a class of nonlinear equations with time delay

Qian Guo
Department of Applied Mathematics, Donghua University, Shanghai, 200051, P.R.China
E-mail: guoqian@dhu.edu.cn
Changpin Li
Department of Mathematics, Shanghai University, Shanghai 200444, P. R. China
E-mail: leecp@staff.shu.edu.cn

This paper considers bifurcations of a class of two-order nonlinear differential equations with time delays. Using the Lyapunov-Schmidt reduction, we study their Hopf bifurcations and periodic solutions. The approximate analytical expressions of the periodic solutions bifurcated from the trivial solution are given. The numerical simulations line up with the theoretical results.

References

[1] Chow, S. N and Hale, J. K. (1982). *Methods of Bifrucation Theory.* Springer-Verlag. New York.

[2] Golubitsky, M. and Schaeffer, D. G. (1985). *Singularities and Groups in Bifurcation Theory.* Springer-Verlag. New York.

[3] Hale, J. K. (1977). *Theory of Functional Differential Equations.* Springer-Verlag. New York.

[4] Hassard,B. D., Kazarinoff, N. D. and Wan,Y. H. (1981). *Theory and Applications of Hopf Bifurcation.* Cambridge.

[5] Li, C. P. (2000). A note on bifurcation of $u''+\mu(u-u^k)=0\,(4\leq k\in Z^+)$. *Applied Mathematics and Mechanics*, **21**(3), pp. 265–274.

[6] Li, C. P. and Chen, G. (2001a). Bifurcation analysis of one-dimensional reaction-diffusion equations. *Int. J. Bifurc. Chaos*, **11**(5), pp. 1295–1306.

[7] Li, C. P. and Chen, G. (2001b). Bifurcation analysis of the Kuramoto-Sivashinsky equation in one spatial dimension. *Int. J. Bifurc. Chaos*, **11**(9), pp. 2493-2499.

Multiplicity Results for Periodic Solutions to Delay Differential Equations via Morse theory

Zhiming Guo and Jianshe Yu
Department of Applied Mathematics
Guangzhou University
Guangzhou, 510405
People's Republic of China
E-mail: gzm100@21cn.com, jsyu@gzhu.edu.cn

By using the infinite dimensional Morse theory, the multiplicity results for periodic solutions to the following system of delay differential equations

$$x'(t)=-f(x(t-r)) \qquad (*)$$

are obtained, where $x\in\mathbf{R}^n$, $f\in C(\mathbf{R}^n,\mathbf{R}^n)$ and $r>0$ is a given constant. This paper provide a new approach to investigate the periodic solutions for delay differential equations.

On the number of limit cycles of near-Hamiltonian polynomial systems

Maoan Han[a] Guanrong Chen[b] Chengjun Sun[c]
a. Shanghai Normal University
b. City University of Hong Kong
c. Shanghai Jiaotong university

Let P denote the space of all polynomials with two variables and having degree m+1 (¿2). For any H in P it induces a Hamitonian system of degree m. Consider a planar polynomial system which is a perturbation of the Hamiltonian system and whose perturbation is of degree n. We prove that the perturbed system has Hopf cyclitciy n(n+1)/2 C 1 at each elementary center and cyclicity n(n+1)/2 at each periodic orbit for almost all Hamiltonian functions H in P.

Adaptive control in chaotic systems

Debin Huang
Department of Mathematics
Shanghai University
Shanghai 200444, P. R. China
E-mail: dbhuang@staff.shu.edu.cn

We compare two different adaptive algorithms controlling chaos, where one was originally set up by Huberman and Lumer [1], and thereafter was developed and implemented in a series of articles by Sinha and his co-workers [2], and the other was recently developed by the author [3]. Besides some interesting properties to be explored we find that the former method is not strict and will fail in general for the continuous systems, but the latter method is effective. However for the discrete cases, although lack of rigorous proof both two methods maybe success in stabilizing chaotic orbits for some specific examples, where the former method seems to be more effective than the latter method. Therefore a rigorous discrete adaptive control algorithm remains open.

References

[1] B. Huberman and H.L. Lumer, IEEE Trans. Circut Syst. **37**, 547 (1990).

[2] S. Sinha, R. Ramaswamy and J. Subba Rao, Physica D **43**, 118 (1990); S. Sinha, Phys. Lett. A **156**, 475 (1991); R. Ramaswamy, S. Sinha and N. Gupte, Phys. Rev. E **57**, R2507 (1998); S. Sinha and N. Gupte, Phys. Rev. E **58**, R5221 (1998); S. Sinha and W.L. Ditto, Phys. Rev. E **63**, 056209 (2001); S. Sinha and N. Gupte, Phys. Rev. E **64**, 015203 (2001).

[3] Debin Huang, Phys. Rev. Lett. **93**, 214101 (2004).

Traveling Waves and Weakly Coupled Traveling Waves for a Model of Growth and Competition in a Flow Reactor

Wenzhang Huang
Department of Mathematical Sciences
University of Alabama in Huntsville
Huntsville, AL 35899, USA

For a reaction-diffusion model of microbial flow reactor with two competing populations, we use the unstable manifold theorem and continuous argument to show the coexistence of traveling wave solutions. In particular, by a bifurcation method we show the existence of weakly coupled traveling wave solutions in the sense that one organism undergoes a population growth while another organism remains in a very low population density in the first half interval of the space line; the population densities then exchange the position in the next half interval. This type of traveling wave can occur only if the input nutrient slightly exceeds the maximum carrying capacity for these two populations. This means, in the lack of adequate nutrient, two competing organisms will manage to survive in a more economical way - an interesting phenomenon.

Convergence in monotone and uniformly stable skew-product semiflows with applications

Jifa Jiang[4]
Department of Applied Mathematics
Tongji University
Shanghai 200092, P. R. China
E-mail: jiangjf@ustc.edu.cn

Xiao-Qiang Zhao[5]
Department of Mathematics and Statistics
Memorial University of Newfoundland
St. John's, NF A1C 5S7, Canada
E-mail: xzhao@math.mun.ca

The 1-covering property of omega limit sets is established for monotone and uniformly stable skew-product semiflows with the componentwise separating property of bounded and ordered full orbits. Then these results are applied to study the asymptotic almost periodicity of solutions to almost periodic reaction-diffusion equations and differential systems with time delays. The earlier convergence results for autonomous and periodic monotone systems are generalized to the almost periodic case without the strong monotonicity assumption.

Key words and phrases: Skew-product semiflows, monotonicity, uniform stability, 1-covering property, minimality, distality, Ellis semigroup, convergence, almost periodic systems, principal spectrum point.

[4]Supported by the NSF of China.
[5]Supported in part by the NSERC of Canada.

The effect of population dispersal on the spread of a disease

Yu Jin
Southwest Normal University
Beipei, Chongqing 400715, CHINA
E-mail: jinyu163@swnu.edu.cn

The effect of population dispersal among n patches on the spread of a disease is investigated. Population dispersal does not destroy the uniqueness of a disease free equilibrium and its attractivity when the basic reproduction number of a disease $R_0 < 1$. When $R_0 > 1$, the uniqueness and global attractivity of the endemic equilibrium can be obtained if dispersal rates of susceptible individuals and infective individuals are the same or very close in each patch. However, numerical calculations show that population dispersal may result in multiple endemic equilibria and even multi-stable equilibria among patches, and also may result in the extinction of a disease, even though it can not be eradicated in each isolated patch, provided the basic reproduction numbers of isolated patches are not very large.

Explosive solutions of higher-order elliptic equations with superlinear growth

Monica Lazzo
Department of Mathematics
University of Bari via Orabona 4, 70125 Bari Italy
Email: lazzo@dm.uniba.it, Phone: 0039 080 544 2702, Fax: 0039 080 596 3612

We study radial solutions of poly-harmonic equations with power nonlinearities and show that the behavior of the solutions can be inferred from the dynamics of an associated system of autonomous ODEs. As a consequence, we obtain existence and multiplicity results for explosive solutions of the underlying elliptic PDEs and a precise description of their blow-up behavior.

A new application of Petrov method to Abelian integrals

Armengol Gasull[1)], Chengzhi Li[2)], and Changjian Liu[2)]
[1)]Departament de Matemàtiques, Universitat Autònoma de Barcelona
Bellaterra, 08193 Barcelona, Spain
[2)]School of Mathematical Science, Peking University Beijing 100871, P.R.China

By using the Argument Principle we give an upper bound for the number of zeros of an Abelian integral. This Abelian integral controls the number of limit cycles that bifurcate, by a polynomial perturbations of arbitrary degree, from the periodic orbits of the integrable system $(1+x)\,dH = 0$, where H is the quasi-homogeneous Hamiltonian $H(x, y) = x^{2k}/(2k) + y^2/2$.

A Competition Model with Toxin Production and An External Inhibitor

Jianquan Li[a,b] Zhien Ma[b] Yicang Zhou[b]
[a]Department of Applied Mathematics and Physics,
Air Force Engineering University, Xi'an 710051, China. E-mail address: jianq_li263.net
[b]Department of Applied Mathematics, Xi'an Jiaotong University, Xi'an 710049, China

In this paper, we consider a competition model of the chemostat with toxin production and an external inhibitor

$$\begin{aligned} &S' = (S^{(0)} - S)D - e^{-\mu C}\tfrac{m_1 S}{a_1+S}\tfrac{x}{\eta_1} - \tfrac{m_2 S}{a_2+S}\tfrac{y}{\eta_2},\\ &x' = x(e^{-\mu C}\tfrac{m_1 S}{a_1+S} - D - \gamma p),\\ &y' = y((1-k)\tfrac{m_2 S}{a_2+S} - D),\\ &p' = k\tfrac{m_2 S}{a_2+S}y - Dp,\\ &C' = (C^{(0)} - C)D - \tfrac{dCy}{a+C}. \end{aligned}$$

The existence of its extinction equilibria is discussed. The theory of asymptotic autonomous systems and Liapunov function are applied to obtain the global stability of extinction equilibria. The condition guaranteeing the existence of the interior equilibrium is given. It is found by numerical simulation that the system may be globally stable, or bistable or have an attracting limit cycle when the interior equilibrium exists.

A Higher Dimensional Poincaré-Bendixson Trichotomy

Michael Y. Li
Applied Math Institute
Department of Mathematical and Statistical Sciences
University of Alberta Edmonton
Alberta T6G 2G1, Canada
Phone: +1 (780) 492-2032, Fax: +1 (780) 492-6826

For autonomous system in $\mathbb{R}^n$, let $\varphi(t)$ be a forwardly bounded solution, and ω be its omega limit set. We prove the following result: if the second compound system associated with $\varphi(t)$ is uniformly asymptotically stable, then ω is either (1) a single equilibrium, or (2) a stable periodic orbit, or (3) a heteroclinic cycle. Our approach is to investigate the asymptotic behaviours of a class of linear differential systems, the second compound systems, that govern the evolution of differential 2-forms along the flow of the nonlinear system. This is a joint work with James Muldowney at the University of Alberta.

Rotation number for Random Dynamical Systems on Circle[6]

Weigu Li[a] Kening Lu[b]
a. School of Mathematics, Peking University
Beijing 100871, P.R. China, E-mail: weigu@math.pku.edu.cn
b. Department of Mathematics, Brigham Young University
Provo, Utah 84602, USA and Department of Mathematics
Michigan State University east Lansing,Michigan 48824, USA
E-mail: klu@math.byu.edu or klu@math.msu.edu

In this paper we generalize the rotation number theory to the random dynamical systems on the circle.

Key words: Multiplicative Ergodic Theorem, random dynamical systems, Sternberg's Theorem, Chen's Theorem, normal forms.

Global Output Convergence of Recurrent Neural Networks with Distributed Delays

Jinling Liang and Jinde Cao
Department of Mathematics, Southeast University, Nanjing 210096, China
jdcao@seu.edu.cn; jinlliang@seu.edu.cn

This paper studies the global output convergence of the following recurrent neural networks with distributed delays:

$$\frac{dx_i(t)}{dt} = \sum_{j=1}^{n} [w_{ij} g_j(x_j(t)) + w_{ij}^{\tau} \int_{-\infty}^{t} k_{ij}(t-s) g_j(x_j(s)) ds] + I_i(t) \qquad i = 1, 2, \ldots, n \tag{0.1}$$

Throughout this paper we assume that:

(H_1) There exist constant scalers $l_i > 0$ such that $0 \leq \frac{g_i(u)-g_i(v)}{u-v} \leq l_i$ for any $u, v \in \mathbb{R}^n$ and $u \neq v$; $i = 1, 2, \ldots, n$.

(H_2) There exists a constant vector $I \in \mathbb{R}^n$ such that $\lim_{t\to+\infty} I(t) = I$.

(H_3) The kernels $k_{ij}: [0, +\infty) \to [0, +\infty)$ are piecewise continuous functions and satisfy

$$\int_0^{+\infty} k_{ij}(s) ds = 1, \qquad \int_0^{+\infty} s^2 k_{ij}(s) ds < +\infty \qquad i, j = 1, 2, \ldots, n.$$

By using the definiteness of matrix and the properties of M-matrix, two sufficient conditions are established to guarantee the global output convergence of this class of neural networks.

Theorem 1. Under the assumptions $(H_1) - (H_3)$, system (1) is globally output convergent if

$$\int_0^{+\infty} \hat{I}_i^2(t) dt < +\infty \qquad (i = 1, 2, \ldots, n)$$

[6]This work was partially supported by NSF0200961 (K. Lu) and the 973 Project of the Ministry of Science and Technology of China (W. Li).

and there exist constants $p_i > 0 \quad (i = 1, 2, \ldots, n)$ such that

$$PW + W^T P + M < 0$$

in which $P = \mathrm{diag}(p_1, p_2, \ldots, p_n)$, $M = \mathrm{diag}(m_i)_{n\times n}$ and $m_i = \sum_{j=1}^{n}(p_i|w_{ij}^{\tau}| + p_j|w_{ji}^{\tau}|)$.

Theorem 2. System (1) is globally output convergent if matrix $S = (s_{ij})_{n\times n}$ is an M-matrix, where

$$s_{ij} = \begin{cases} -w_{ii} - |w_{ii}^{\tau}| & \text{if } i = j; \\ -|w_{ij}| - |w_{ij}^{\tau}| & \text{if } i \neq j. \end{cases}$$

Theorems 1 and 2 provided two different sufficient conditions ensuring system (1) to be globally output convergent. Generally speaking, both of them have advantages in different problems and applications. The results obtained in this paper generalize the earlier works [1,2,3] and they are useful in solving some optimization problems and in the design of recurrent neural networks with distributed delays.

References

[1] J. Cao, J. Wang, X.F. Liao, Novel stability criteria for delayed cellular neural networks, International Journal of Neural Systems **13** (2003) 367-375

[2] D. Liu, S. Hu, J. Wang, Global output convergence of a class of continuous-time recurrent neural networks with time-varying threshoulds, IEEE Transactions on Circuits and Systems-II **51** (2004) 161-167.

[3] S. Hu, D. Liu, On the global output convergence of a class of recurrent neural networks with time-varying inputs, Neural Networks **18** (2005) 171-178.

Dynamics of Type-K Monotone and Competitive Systems

Xing Liang
University of Science and technology of China
E-mail: xliang@ustc.edu.cn

In this talk, we will introduce the concepts of type-K monotone and competitive systems, and then discuss the dynamical behavior of these systems. More precisely, we will show that the dynamics of such a n-dimensional system is n-1 dimensional.

Next we will introduce the index theory of equilibria, and use it to give classifications of 3-dimensional type-K monotone and competitive Lotka-Volterra systems.

Dafermos regularization and an L2 semigroup for the hyperbolic conservation laws

Xiao-Biao Lin
Department of Mathematics
North Carolina State University
Raleigh, NC 27695-8205 USA

Riemann solutions for the systems of conservation laws $u_t + f(u)_x = 0$ are self-similar solutions of the form $u = u(x/t)$. Using the change of variables $\xi = x/t, \tau = ln(t)$, Riemann solutions become stationary to the system $u_\tau + (Df(u) - \xi I)u_\xi = 0$. I will introduce a L2 semigroup for the linear variational systems around the Riemann solutions of the hyperbolic conservation laws. Eigenvalues of the linear system corresponds to zeros of the determinant of a transcendental matrix. If γ is greater than the largest real parts of the eigenvalues, then the semigroup is of $O(exp(\gamma\tau))$ in a weak sense. This work can be applied to the linear stability of Riemann solutions of conservation laws and the stability of nearby solutions of the Dafermos regularizations, i.e. $u_\tau + (Df(u) - \xi I)u_\xi = \epsilon u_{\xi\xi}$.

Asymptotic and Periodic Behavior for Natural Growth Dynamic Equations on Time Scales[7]

AiLian Liu and SiMing Zhu
Department of Mathematics, Zhongshan University

The time scales ($\mathbb{T}$) theory, which has received a lot of attention recently, was founded by Stefan Hilger (1988) in his doctor dissertation in order to unify and generalize the study of continuous and discrete analysis. In this paper, we first discuss the stability of the first-order linear and nonlinear dynamic equations on time scales

$$x^{\Delta}(t) = p(t)x(t) \qquad t \in \mathbb{T}, \quad x \in \mathbb{R} \tag{0.2}$$

$$x^{\Delta}(t) = p(t)x(t) + f(t, x(t)) \qquad t \in \mathbb{T}, \quad x \in \mathbb{R} \tag{0.3}$$

here $\lim_{x\to 0} |\frac{f(t,x)}{x}| = 0$. A new relationship of functions is imported and the Lyapunov indirect method on time scales is used. The results obtained are corrections and supplement of the present. When $p(t) = p$(nonzero real constant), we prove the generalized perron-type theorem on any time scales, with specific reference given to how the graininess of the time scales affects stability.

The properties of periodic dynamic equations on periodic time scales are also explored. Then on a specific but practical time scales, the dynamic natural growth equation is analyzed thoroughly and some stability criteria are established in terms of the coefficient and the graininess.

At last, the linear dynamic systems on plane and high-dimension space are discusseded qualitatively, which reveals the essential discrepancy between continuous and discrete dynamical systems.

[7]Project supported by the National Natural Scientific Foundation of China (No. 10371135); This work is also supported in part by the Foundation of Zhongshan University Advanced Research Centre05M12

Turning points and traveling waves in FitzHugh-Nagumo type equations

Weishi Liu
Department of Mathematics
University of Kansas
1460 Jayhawk Blvd., Room 405
Lawrence, KS 66045, USA
E-mail: wliu@math.ku.edu

Consider the following generalized FitzHugh-Nagumo equation

$$u_t = u_{xx} + f(u, w), \quad w_t = \epsilon g(u, w)$$

where $f(u, w) = u(u - a(w))(1 - u)$ for some smooth function $a(w)$ and $g(u, w) = u - w$. It turns out whenever $a(w)$ crosses zero and one, a turning point is created in the traveling wave equation which result in very rich dynamics. In this talk, we apply geometric singular perturbation theory and heteroclinic bifurcation method to examine the existence of fronts, backs and pulses solutions; in particular, the co-existence of different fronts will be discussed.

Synchronization of dynamical networks with uncertainty

Xinzhi Liu
Department of Applied Mathematics
University of Waterloo
Waterloo, Ontario
Canada N2L 3G1
E-mail: xzliu@uwaterloo.ca

Synchronization of chaotic systems has been an active area of research since the 1990's. Numerous methods have been developed for chaos synchronization. Recently, synchronization of dynamical networks has been reported in the literature. A dynamical network consists of coupled nodes, which may be chaotic systems. The network coupling functions may be unknown a priori and may be linear or nonlinear. This paper studies robust impulsive synchronization of dynamical networks with Uncertainty. Based on the concept of impulsive control, several criteria for robust local and robust global synchronizations are established for complex dynamical networks in which the network coupling functions are unknown but bounded. Some examples are worked out to illustrate the analytical results.

Two New Types of Bounded Waves of Camassa-Holm Equation

Zheng-rong Liu
School of Mathematical Sciences,
South China University of Technology,
Guangzhou, 510640, P. R. China
E-mail: liuzhr@scut.edu.cn

In this paper, the bifurcation method of planar systems and simulation method of differential equations are employed to investigate the bounded waves of the Camassa-Holm equation.

$$u_t + 2ku_x - u_{xxt} + 3uu_x = 2u_x u_{xx} + uu_{xxx}$$

Two new types of bounded waves are found and their implicit expressions are obtained. Both qualitative and numerical results show that they possess some properties of compactons or kink waves. Therefore they are called compacton-like and kink-like wave respectively.

Topology Implies Performance in the Associative Memory Neural Networks

Jianquan Lu and Jinde Cao
Department of Mathematics, Southeast University, Nanjing 210096, China
lujianquan1981@126.com; jdcao@seu.edu.cn

To explore how topology affects performance within Hopfield-type associative memory neural networks[1], we studied the computational performance of this kind of neural networks with regular lattice, random network[2], small-world network[3], and scale-free structure[4][5][6]. Two notions were proposed to measure the performance of the associative memory neural networks: the stability of the memorized patterns which is inversely related to the number of errors induced by crosstalk and the network's retrieval ability to recall the corrupted patterns. In this paper, we used the final similarity order parameters:

$$m_{final} = \frac{1}{P}\sum_{u=1}^{P} m^u, \qquad where \;\; m^u = \frac{1}{N}\sum_{i=1}^{N} s_i \xi_i^u \tag{0.4}$$

in which the $\{\xi_i^u\}$ $(i = 1, 2, \cdots, N;\ u = 1, 2, \cdots, P)$ are the stored P patterns with length N and $s_i = \pm 1$ is the output of the ith node.

By using the notions mentioned-above, we get the following conclusions via simulation:

Conclusion 1. The memory capability obtained through asynchronous updating from "larger" nodes to "smaller" nodes are better than asynchronous updating in random order, especially for scale-free topology.

Conclusion 2. Comparing the computational performance of these structures mentioned above with the same amounts of nodes and edges, we found that the more disorder and randomness the graph exhibits, the less locality it exhibits, then higher the associative memory ability.

Conclusion 3. An interesting phenomenon was shown in this paper: in certain condition, the performance of random configuration is better than that of scale-free structure; it is opposite otherwise.

According to the conclusions got in this paper, we can design different kinds of associative memory neural networks with high performance and minimal interconnect requirements for each purpose.

References

[1] J. J. Hopfield, " Neural networks and physical systems with emergent collective computational abilities, " Proc. Natl. Acad. Sci. USA 79, pp. 2445-2458, 1982.

[2] B. *Bollobás*, Random graphs, Academic Press, New York, 1985.

[3] D. J. Watts and S. H. Strogatz, " Collective dynamics of 'small-world' networks, " Nature, vol. 393, pp.440-442, 1998.

[4] A. L. *Barabási* and R. Albert, " Emergence of scaling in random networks, " Science, vol. 286, pp. 509-512, 1999.

[5] K. Klemm and V. M. Eguíluz, " Growing scale-free networks with small-world behavior, " Phys. Rev. E, vol. 65, no. 5, pp. 7102-7105, 2002.

[6] K. Klemm and V. M. Eguíluz, " Highly clustered scale-free networks, " Phys. Rev. E, vol. 65, no. 3, pp. 6123-6127, 2002.

Estimating The Global Basin of Attraction and Positively Invariant Set for The Lorenz System

Jun-an Lu, Damei Li, Xiaoqun Wu
School of Mathematics and Statistics, Wuhan University
Hubei 430072, China
E-mail:jalu@whu.edu.cn

Abstract: A chaotic system is bounded, and the estimate of its bound is important in chaos control, chaos synchronization and their applications. Technically, this is also a very difficult task. In our conference report, we will investigate the global basin of attraction (or ultimate bound) and positively invariant set for the Lorenz system. Ever since it was put forward in 1963, researchers have been investigating its global basin of attraction. It was only in 1987 that Leonov et al.derived a spherical estimate and a cylindrical estimate for the Lorenz system [1]. Recently, Li et al. [2] derived a sharper upper bound for the Lorenz system, for all the positive values of its parameters a and b, which extends and improves the results in [1]. Liao also presented an ellipsoidal estimate of the ultimate bound for the Lorenz system [3], but only for a ¿= 1 and b ¿= 2. In our report, we will use the combined techniques of generalized Lyapunov function and optimization to investigate the global basin of attraction and positively invariant set for the Lorenz system. Comparing with the best results existing in the current literature [1C3], we fill the gap of the estimate for 0 ¡ a ¡ 1 and 0 ¡ b ¡ 2. Whats more, our results are relatively accurate. The theoretical results derived here will find its wide applications. KEY WORDS: The Lorenz system, global basin of attraction,ultimate bound, positively invariant set, Lyapunov function

References

[1] Leonov G, Bunin A, Koksch N, Attractor localization of the Lorenz system, ZAMM, 1987; 67: 649-656.

[2] Damei Li, Jun-an Lu, Xiaoqun Wu , Guanrong Chen, Estimating the bounds for the Lorenz family of chaotic systems, Chaos, Solitons and Fractals, 2005; 23: 529-534.

[3] Liao Xiaoxin, On the global basin of attraction and positively invariant set for the Lorenz chaotic system and its application in chaos control and synchrnization, Science In China Ser. E Information Sciences, 2004, 34(12): 1404-1419

Smooth conjugacy for random dynamical systems

Kening Lu
Michigan State University and Brigham Young University, USA

The study of reducing a nonlinear deterministic dynamical system to the simplest possible form (called a normal form) goes back to Poincare and Birkhoff. In this talk, I will report our recent work on smooth conjugacy for random dynamical systems. Our results include extensions of Poincare, Sternberg, and Takens theorems in deterministic cases to random dynamical systems. In our work on finitely smooth conjugacy, we settle an open problem raised by L. Arnold.

We should mention that all the nonresonant conditions here are in terms of Lyapunov exponents, which reflects the limit behavior of systems. That the Lyapunov exponents satisfy a nonresonant condition does not imply that the eigenvalues of the linearized random matrix satisfy a nonresonant condition and vice versa. The linearized system is also nonuniformly hyperbolic in the sense of Pesin for deterministic systems.

We will also present a stable and unstable manifold theorem with tempered estimates which are used in the construction of conjugacy.

Random dynamical systems arise in the modeling of many phenomena in physics, biology, climatology, economics, etc. when uncertainties or random influences, called noises, are taken into account. These random effects are not only introduced to compensate for the defects in some deterministic models, but also are often rather intrinsic phenomena.

This is a joint work with Weigu Li.

Global Weak Solutions for Gas Dynamics System and Related Systems

Yunguang Lu
National University of Colombia

An important class of the equations arising in applications are the nonlinear system of conservation laws. The basic question in this area is the existence of solutions to these equations. This helps to answer the question if the model of the natural phenomena at hand has been done correctly, if the problem is well posed.

In the past years, we studied the existence of weak solutions for some nonlinear hyperbolic equations arisen in the compressible fluid and gas mechanics. The method we used in the study is the theory of the compensated compactness.

Optimal Control for Linear Population Dynamics with Diffusion in a Periodic Environment

Zhixue Luo
Department of Mathematics
Lanzhou Jiaotong University
Lanzhou 730070, China

The present paper is concerned with the optimal control problem for linear population dynamics with age-dependence and spatial structre in a periodic environment. By using Mazur's Theorem, we demonstrate existence of solutions of the optimal control problem and by the conception of normal cone, we also obtain the first order necessary conditions of optimality for problem . Our results extend the corresponding research of linear models.

Keywords: periodic, diffusion, optimal control, system of partial differential equations, population dynamics, age-dependent, Pontryagin's principle.

What are complexiton solutions of integrable equations?

Wen-Xiu Ma
Department of Mathematics
University of South Florida
Tampa, FL 33620-5700
E-mail: mawx@math.usf.edu, Tel: (813)974-9563, Fax: (813)974-2700

Complexiton solutions are a novel class of exact solutions to integrable equations. Starting with the solution classification for a linear differential equation, bilinear forms are used to construct complexiton solutions in the Wronskian or Casoratian form. The solution procedure will be exhibited for the Korteweg-de Vries equation and the Toda lattice equation, and their complexiton solutions will follow, along with rational solutions, positons, negatons and interaction solutions.

Key words: Bilinear form, the Wronskian and Casoratian techniques, Soliton, Positon, Complexiton

Qualitative Analysis on Some Epidemic Dynamic Models with Vaccinations

Zhien Ma[1] and Jianquan Li[2]
[1] Xi'an Jiaotong University, E-mail: zhma@mail.xjtu.edu.cn
[2] Air force Engineering University

It is well know that for investigate a dynamic behaviors of Epidemic model with vaccination one usually use so call SIR compartment model. But if the immunity caused by vaccination is temporary and the periods of immunity loss for vaccinated and recovered are not the same, then another compartment V should be introduced. In this article we will investigate the effect of the vaccinations to the newborns and to the susceptibles for SIS-V, SIR-V and SIRS-V models. The models described by differential equations and time delay equations are both studied and the thresholds or so call reproductive numbers to determine the extinction or persistence of the disease for these models are obtained. The effects of vaccination for the newborns and susceptibles are compared.

We also investigated the effects of efficiency of the vaccine to the spread of disease. The interesting results we obtained is that if the efficiency of the vaccine is not one hundred percent, then the so call backward bifurcation will appear, which means that, even if the reproductive number is less than one, the disease may not be extinct, and the period of persistence of the disease in this case has been found. This results exhort us that in order to prevent and control the spread of disease, estimating accurately the efficiency of vaccine is necessary and very important.

Equivalent Transformations of 3-Manifolds

Jiehua Mai
Institute of Mathematics
Shantou University
Guangdong, 515063, P.R.China
Email: jhmai@stu.edu.cn

In this paper we use a handle-body with circles to express a closed 3-manifolds. Our expression is more intuitive and clearer than the well known Heegaard Splitting. Basing on isotopies on boundaries of 3-manifolds, we raise some techniques and methods to simplify handle-bodies with circles. These techniques and methods contain:

★ Equivalent Handle-bodies with Circles
★ Partition of Circles
★ Detouring of Circles
★ Addition and Deletion of Circles
★ Sinking of Handles
★ Separation Degrees of Handles
★ Merger and Split of Handles
★ Reducible Handle-Bodies with Normal Circles
★ Decrease of Separation Degrees of Handles
★ Regular Disks in 3-Manifolds
★ Sliding of Handles

Principal Poincaré-Pontryagin function

Pavao Mardešić
Institut Mathématique de Bourgogne, Université de Bourgogne, Dijon, France

Let $H(x,y) \in \mathbb{C}[x,y]$ be a polynomial, let Y be a polynomial vector field and let $\delta(h)$ be a continuous family of loops in $H^{-1}(h)$. We consider the Poincaré map P_ϵ of the deformation

$$X_\epsilon = X_H + \epsilon Y$$

of the Hamiltonian X_H associated to H along $\delta(h)$. Parametrising a transversal by the values h of the Hamiltonian H, we have

$$P_\epsilon(h) = h + \sum_{i=0}^{\infty} \epsilon^{i+1} M_i(h).$$

We call the functions M_i Poincaré-Pontryagin functions and we call the first nonzero Poincaré-Pontryagin function the principal Poincaré-Pontryagin function.

Françoise gave an algorithm for calculating the principal Poincaré-Pontryagin function under a generic assumption. We present some works with Jebrane and Pelletier, as well as works of Uribe, where Françoise condition is not verified, but we can calculate the principal Poincaré-Pontrayagin function. We explain why in some cases it is an Abelian integral, while in other it is not.

On smoothness of carrying simplices in totally competitive systems of ODE's

Janusz Mierczyński
Institute of Mathematics, Wrocław University of Technology
Wybrzeże Wyspiańskiego 27 PL-50-370 Wrocław, Poland
e-mail: mierczyn@pwr.wroc.pl

A system of ordinary differential equations (ODE's) $\dot{x}_i = x_i f_i(t, x)$ is called *totally competitive* if $\partial f_i/\partial x_j < 0$ for all $1 \le i, j \le N$ on the orthant $\mathbb{R}^N_+ := \{x \in \mathbb{R}^N : x_i \ge 0\}$. Assume moreover that f_i are periodic in t. For a dissipative totally competitive system in which $\{0\}$ is a repeller there exists an invariant (under the period map) set Σ, homeomorphic to the standard probability $(N-1)$-simplex, and such that none of whose distinct points are ordered by the standard coordinatewise relation $\le$. Moreover, such a Σ (called the *carrying simplex*) uniformly attracts any bounded set bounded away from $\{0\}$. The existence of a carrying simplex was proved by M. W. Hirsch in the autonomous case and by Jifa Jiang and Yi Wang in the time-periodic case.

A natural question (posed in fact by M. W. Hirsch) arises whether Σ is smooth. It comes out that various possibilities occur:

- Σ is a C^1 submanifold-with-corners, neatly embedded in $\mathbb{R}^N_+$. A pleasant sufficient condition for that can be given, namely, that a system, together with all its subsystems, is uniformly persistent (permanent).
- Σ is a C^1 submanifold-with-corners, but at some portion of its boundary, it is tangent to the corresponding face of the orthant (hence it is not neatly embedded).
- At some face, Σ is neither tangent nor transverse to the corresponding face of the orthant.

(The above results are due to Jifa Jiang, Yi Wang and myself.)

In each of the above cases the carrying simplex ceases to be smooth at some part of its boundary. In fact, thanks to a result of I. Tereščák one can prove that the basin of any repeller (for the restriction to Σ) contained in the interior $\mathbb{R}^N_{++} := \{x \in \mathbb{R}^N : x_i > 0\}$ is a C^1 submanifold.

I conjecture that indeed the carrying simplex is C^1 everywhere in $\mathbb{R}^N_{++}$.

Global bifurcation structure of a 1-d Ginzburg-Landau model

Yoshihisa Morita
Department of Applied Mathematics and Informatics
Ryukoku University
Seta Otsu 520-2194 Japan
E-mail: morita@rins.ryukoku.ac.jp

We are dealing with a simplified model of the superconductivity in a thin uniform superconducting ring. The energy functional in a non-dimensional form of such a model is given by

$$E(\psi) := \int_0^{2\pi} \frac{1}{2}|D_h\psi|^2 + \frac{\lambda}{4}(1-|\psi|^2)^2 dx, \quad D_h := d/dx - ih(x), \tag{0.5}$$

where ψ is a complex-valued order parameter, λ is a positive parameter and $h(x)$ is a smooth periodic function. Then the Euler-Lagrange equation of the functional is obtain as

$$\begin{cases} D_h^2\psi + \lambda(1-|\psi|^2)\psi = 0, & x \in \mathbb{R}, \\ \psi(x+2\pi) = \psi(x), & x \in \mathbb{R}, \end{cases} \tag{0.6}$$

which is the Ginzburg-Landau equation of this model. Here we assume

$$h(x) = \mu h_e(x), \quad \frac{1}{2\pi}\int_0^{2\pi} h_e(s)ds = 1.$$

We reveal a global bifurcation structure of solutions to (0.6) in the parameter space (μ, λ) and determine minimizers of (0.5). In fact we solve all the solutions explicitly and exhibit the configuration of the solutions. We also show how secondary bifurcating solutions deforms as μ varies. The main results are due to the recent joint work with Satoshi Kosugi and Shoji Yotsutani (Ryukoku University).

A role of codim 3 singularities arising in the collision dynamics among particle-like patterns in dissipative systems

Yasumasa Nishiura
Laboratory of Nonlinear Studies and Computation Research Institute for Electronic Science
Hokkaido University Sapporo 060-0812 Japan
TEL: +81-11-706-3357 FAX: +81-11-706-4966
E-mail: nishiura@aurora.es.hokudai.ac.jp

Abstract: Scattering of particle-like patterns in dissipative systems is studied, especially we focus on the issue how the input-output relation is controlled at a head-on collision where traveling pulses or spots interact strongly. It remains an open problem due to the large deformation of patterns at a colliding point. We found that special type of unstable steady or time-periodic solutions called scattors and their stable and unstable manifolds direct the traffic flow of orbits. Such scattors are in general highly unstable even in 1D case which causes a variety of input-output relations through the scattering process. In this talk we also discuss the issue that how the scattering dynamics change when scattors undergo bifurcations of codim 3 type as well as illustrating the ubiquity of scattors by using the complex Ginzburg-Landau equation, the Gray-Scott model and a three-component reaction diffusion model arising in gas-discharge phenomena.

Moment exponential stability of stochastic Cohen-Grossberg neural network with time-varying delays

Jianren Niu
Department of Mathematics
Sichuan University
Chengdu, Sichuan
P. R. China
E-mail: niujianren@sina.com.cn

The main aim of this paper is to discuss moment exponential stability for a stochastic Cohen-Grossberg neural network with time-varying delays. Using the Ito formula, delays differential inequality and the characteristics of stochastic delay neural networks, the moment exponential stability is derived.

Almost automorphic and almost periodic dynamics for quasimonotone non-autonomous delay differential equations

Sylvia Novo, Carmen Nunez, and Rafael Obaya
Universidad de Valladolid, Spain

Conditions establishing the occurrence of almost automorphic and almost periodic dynamics for monotone non-autonomous recurrent finite-delay functional differential equations are established. Topological methods are used in order to ensure the presence of almost automorphic dynamcis for a monotone skew-product semiflow in the case of existence of a semicontinuous semi-equilibrium. When the semiflow arises from a recurrent quasimonotone finite-delay differential equation, and if the semi-equilibria are continuous and strong, the presence of almost automorphic extensions of the base flow is persistent under small perturbations. These methods show the existence of almost-periodic minimal sets under an additional convexity condition. Some examples show the applicability of these results.

Exponential stable minimal sets generated by non-autonomous differential equations

Rafael Obaya
Universidad de Valladolid, Spain

We consider the skew-product-semiflows generated by some kind of non-autonomous functional differential equations. We prove that a minimal set with negative upper Lyapunov exponent is a n-copy of the base. We consider some conditions wich assure that the minimal is a copy of the base. We deduce some theorems of attractivity assuming that the semiflow is monotone and convex. We apply these results to equations which appear in the mathematical theory of neural networks. This is a join work with Sylvia Novo and Ana Sanz.

Stability Analysis for Dynamic Equations on Time Scales Supported by the NNSF of PR China(NO.10371135) and the Foundation of Zhongshan University Advanced Research Centre(05M12).

Liuman Ou Siming Zhu
Dep. of Math., Zhongshan University, Guangzhou 510275,China
E-mail: mcp02olm@student.zsu.edu.cn

It is all well known that Lyapunov direct method is the core of the whole stability theory not only in ODE but also in DDE. Using Lapunov-type function and inequality theory, people have once obtained all but perfectly stability theory, and abundantly imprint the equation's qualitative behaviors. But many works are iterative, in fact, many analogous results can be unified totally. This benefits from the new theory known as dynamic systems on time scales which has been vigorously built recently. We point out that the definition of Dini-derivative in [3] is wrong and that in [6] is not rational, the one-sided of the definition of the exponential stability in [8,9] is alse proposed. And these definitions will be defined anew in this paper. Each kind of Lyapunov's stability criteria (stable, uniformly stable, asymptotically stable,exponential asymptotically stable, etc.) are obtained for dynamic equations on time scale. The obtained results extend those for time-varying linear dynamic equations in [10].
Keywords: Time scale, the direct Lyapunov's method, dynamic equations,stable criteria.

$\tau - D$ decomposition of a transcendental equation $\lambda^2 + a\lambda + be^{-\lambda\tau} = 0$

Jiaqi Pan
School of Math. and Statistics
Northeast Normal University
Changchun 130024
P. R. China
School of Basic Sciences
Changchun University of Technology
Changchun 130012
P. R. China

In this paper, we provide a bifurcation diagram of a transcendental equation, $\lambda^2+a\lambda+be^{-\lambda\tau} = 0$ by using the $\tau - D$ decomposition, with this diagram one can determine the stability domain of the equilibrium and Hopf bifurcation curves for some time-delay differential equations in the parameter space (τ, a, b).

Dynamics and universality of an isothermal combustion problem in 2D

Yuanwei Qi
University of Central Florida, USA
E-mail: yqi@pegasus.cc.ucf.edu

In this talk, we study the Cauchy problem of a 2D isothermal auto-catalytic chemical reaction. Through Renormalization Group Method, we can identify important parameter ranges where a non-Gaussian universal profile prevail. We shall also report some recent progress on a related model–Scott-Gray model for existence and non-existence of both homoclinic and heteroclinic orbits.

Invariant Tori for Periodic and Quasi-periodic Impact Oscillators

Dingbian QIAN
School of Mathematical Sciences, Suzhou University,
Suzhou, 215006, P.R.China,
Email: dbqian@suda.edu.cn

In this talk, we concern the investigation of invariant tori and quasi-periodic solutions for asymptotically linear impact oscillators with periodic or quasi-periodic force term

$$\begin{cases} x'' + a^2 x + \phi(x) = p(t), \quad \text{for } x(t) > 0; \\ x(t) \geq 0; \\ x(t_0) = 0 \ \Rightarrow x'(t_0+) = -x'(t_0-). \end{cases}$$

Impact oscillator is the typical model with nonsmoothness due to the impacts. Our arguments based on the successor map, some generalized versions of the Moser's twist theorems and detail analysis for the relationship between the existence of the invariant tori and the existence of quasi-periodic solutions. Some comments on further research are also given.

Bifurcation to quasi-periodic discrete breathers in lattice dynamical systems with exponentially decaying coupling

Wen-Xin Qin
Department of Mathematics
Suzhou University
Suzhou, 215006, P.R.China
E-mail: wxqin@public1.sz.js.cn

In this talk we consider the bifurcation of quasi-periodic discrete breathers in coupled map lattices. The individual map being coupled is the delayed logistic map. The coupling scheme is exponentially decaying, including finite range coupling. We reduce the system to the center manifold and then apply Hopf-bifurcation theory to obtain the existence of quasi-periodic discrete breathers for weak coupling. The rotation number is non-constant and continuous with respect to the coupling coefficient.

Boundedness and Exponential Stability for High-Order Neural Networks with Time-Varying Delay

Fengli Ren and Jinde Cao
Department of Mathematics, Southeast University, Nanjing 210096, China
flren1@163.com; jdcao@seu.edu.cn

This paper investigates the boundedness and the global exponential stability of the following high-order neural networks with time-varying delay:

$$\dot{x_i} = -a_i x_i + \sum_{j=1}^{L} w_{ij} f_j(x(t)) + \sum_{j=1}^{L} w_{ij}^{\tau} f_j(x(t-\tau(t))), \qquad i = 1, 2, \cdots, n, \tag{0.7}$$

where

$$f_j(x(t)) = \prod_{k \in I_j} [g_k(x_k(t))]^{d_k(j)}, \tag{0.8}$$

$\{I_1, I_2, \cdots, I_L\}$ is a collection of L not-ordered subsets of $\{1, 2, \cdots, n\}$, $d_k(j)$ are positive integers, $\tau(t)$ is the transmission delay, which is a nonnegative, continuous function defined on $\mathbb{R}^+$ with $\tau(t) \leq \tau < \infty$, $g_i(\cdot)$ are activation functions with $g_i(0) = 0$.

Throughout this paper we assume that:

($A1$) There exist constants $\mu_i > 0$ such that $|g_i(u)| \leq \mu_i |u|$, for all $u \in \mathbb{R}$, $i = 1, 2, \ldots, n$.

(A_2) $g_i(u)| \leq 1$, for all $u \in \mathbb{R}$, $i = 1, 2, \ldots, n$.

($A3$) There are constants $h_{ikj}, l_{ikj}, h_{ikj}^*, l_{ikj}^* \in \mathbb{R}, w_i > 0$ and $r > 1$ such that

$$r a_i w_i - (r-1) \sum_{j=1}^{L} \sum_{k \in I_j} |w_k w_{ij}|^{\frac{r-h_{ikj}}{r-1}} \mu_k^{\frac{r-l_{ikj}}{r-1}} - \sum_{j=1}^{L} \sum_{k \in I_j} |w_k w_{ij}|^{h_{ikj}} \mu_k^{l_{ikj}}$$

$$-(r-1) \sum_{j=1}^{L} \sum_{k \in I_j} |w_k w_{ij}^{\tau}|^{\frac{r-h_{ikj}^*}{r-1}} \mu_k^{\frac{r-l_{ikj}^*}{r-1}} - \sum_{j=1}^{L} \sum_{k \in I_j} |w_k w_{ij}^{\tau}|^{h_{ikj}^*} \mu_k^{l_{ikj}^*} > 0,$$

for all $t \geq 0$, where $i = 1, 2, \cdots, n$; $j = 1, 2, \cdots, L$; $k \in I_j$; μ_k are Lipschitz constants.

We obtained the following results:

Theorem 1. Under the assumptions $(A_1) - (A_3)$, then all solutions of system (0.7) are defined and are bounded on $\mathbb{R}^+$.

Theorem 2. Under the assumptions $(A_1) - (A_3)$, then the origin of system (0.7) is globally exponentially stable.

The obtained results improve and extend those in [1,2,3].

References

[1] J. Liang, J. Cao, Boundedness and stability for recurrent neural networks with varibale coefficients and time-varying delays, Phys. Lett. A, **318** (2003) 53-64.

[2] D. Zhou, J. Cao, Globally exponential stability conditions for cellular neural networks with time-varying delays, Appl. Math. Comput., **131** (2002) 487-496.

[3] J. Cao, J. Wang, Global exponential stability and periodicity of recurrent neural networks with time delays, IEEE Trans. Circuits Syst. I, **52** (2005).

Bifurcations of relaxation oscillations in dimension two

Robert Roussarie
Université de Bourgogne

The talk deals with bifurcations of relaxation oscillations in two-dimensional slow-fast systems depending on some critical small parameter ε, with emphasis on Liénard equations. Attention goes to the investigation of the transient canard oscillations during the bifurcation as well as to the techniques used in proving the results. More precisely, one wants to describe one of the possible mechanisms which can create such canard oscillations bifurcating from *canard cycles* existing for $\varepsilon = 0$: this may happen when *two extrema of the critical curve are crossing together* (i.e. pass by the same value, in a generic way). Under generic assumptions, the asymptotic near the canard cycle is completely determined by a simple integral function (called *slow divergence integral*) which depends in an algebraic way on the parameters of the system and on the position of the canard cycle. One can deduce from this result existence of slow-fast Liénard systems in which appear an arbitrarily number of canard oscillations by this crossing mechanism. This result can also be considered as a first step in the direction of the solution of a recent *conjecture by S. Smale* on the Liénard systems. The talk relies on recent joint work with Freddy Dumortier.

Invariance principle of discrete system and its applications

Wei Lin and Jiong Ruan
School of Mathematical Sciences
Research Center for Nonlinear Sciences
Fudan University
Shanghai 200433, P. R. China

New invariance principle of discrete system, which is somewhat different from the existent criteria, is introduced in this talk. Possible applications and simulations are further provided to illustrate the feasibility of this principle.

Some Bifurcation Problems arise from Studying Biological and Epidemiological Models

Shigui Ruan
Department of Mathematics
University of Miami
Carol Gables, FL 33124-4250
USA

Since many biological phenomena can be modeled by a set of differential equations according to certain idealized physical laws, it is very important to understand the dynamics of these equations in order to understand the biological phenomena. The physical laws are modeled in terms of parameters, so it is crucial to determine how many parameters and how these parameters affect the dynamics of the system. There are many interesting and challenging bifurcation problems in biological models, such as homoclinic bifurcations and chaos in epidemic models, higher codimension (2, 3 or 4) bifurcations in predator-prey models, Bogdanov-Takens bifurcation in delayed biological models, etc. In this talk I will introduce some bifurcation problems arise from studying various biological and epidemiological models.

Monotone Local Semiflows with Saddle-Point Dynamics

Paul G. Schmidt
Department of Mathematics and Statistics
Auburn University, AL 36849-5310, USA
E-mail: pgs@cam.auburn.edu, Phone: 334-844-6579, Fax: 334-844-6555

We seek to describe the dynamics of monotone local semiflows in ordered Banach spaces, for which zero and infinity are stable attractors, while all other equilibria are unstable. Abstract results are applied to systems of cooperative ODEs and semilinear reaction-diffusion equations with superlinear growth.

Spectral Theory for Nonautonomous Dispersal Evolution Equations

Wenxian Shen
Department of Mathematics
Auburn University
E-mail: wenxish@mail.auburn.edu

The current talk is concerned with spectrum for nonautonomous dispersal evolution equations, including parabolic and convolution ones as special cases. It discusses to what extent the principal eigenvalue theories for elliptic or time-periodic parabolic equations can be extended to nonautonomous dispersal equations. Special attention is given to the effect of time variation on the so called principal dynamical spectrum or principal Lyapunov exponent. It shows that the principal dynamical spectrum is always greater than or equal to that of the associated time-averaged one, which has an important biological implication, that is, spatial-temopral variation "favors" population's persistence.

Allee Effect, Bistability and Protection Zone in Spatially heterogeneous Reaction-Diffusion Systems

Junping Shi
Department of Mathematics
College of William and Mary
Williamsburg, VA 23187-8795, USA
and
Harbin Normal University, China
E-mail: shij@math.wm.edu, Fax: 1-757-221-7400

A spatially heterogeneous reaction-diffusion system modelling predator-prey interaction is studied, where the interaction is governed by a Holling type II functional response. Existence of multiple positive steady states and global bifurcation branch are examined as well as related dynamical behavior. It is found that while the predator population is not far from a constant level, the prey population could extinguish, persist or blow up depending on the initial population distributions, the various parameters in the system, and the heterogeneous environment. In particular, we examine a situation where the Allee effect is caused by the spatial heterogeneity of the environment.

Our mathematical approach relies on bifurcation theory, topological methods, various comparison principles and elliptic estimates. If time allows, a diffusive predator-prey system with a protection zone for prey will also be discussed. This is a joint work with Yihong Du of University of New England, Australia.

On the Existence of Positive Solutions of p-Laplacian Functional Difference Equation

Changxiu Song, Peixuan Weng
School of Mathematical Sciences
South China Normal University
Guangzhou 510631, P. R. China

In this paper, the authors study the boundary value problems for a $p-$Laplacian functional difference equation:

$$\begin{aligned} &\triangle\phi_p(\triangle x(t)) + \lambda r(t) f(x(t), x(\varphi(t)) = 0,\ t \in [0, T], \\ &x_0 = \psi, x(0) - B_0(\triangle x(0)) = 0, \triangle x(T+1) = 0, \end{aligned} \tag{1.1}$$

where $\lambda > 0$ and $\phi_p(u)$ is the $p-$Laplacian operator, i.e., $\phi_p(u) = |u|^{p-2}u,\ p > 1,\ (\phi_p)^{-1}(u) = \phi_q(u),\ \frac{1}{p} + \frac{1}{q} = 1$. As usual, $\triangle$ denotes the forward difference operator defined by $\triangle x(t) = x(t+1) - x(t)$.

By using a fixed point theorem in cones, sufficient conditions are established for the existence of the positive solutions.

Keyword: Boundary value problem, p-Laplacian functional difference equations , Positive solution, Fixed point theorem in cones

AMS subject classification: 39A05

Spectral Stability of Shock Waves

Peter Szmolyan
Institute for Analysis and Scientific Computing
Technische Universität Wien, Austria
E-mail: szmolyan@tuwien.ac.at

Results on the stability of viscous shock waves in one and several space dimensions are presented. In the context of Evans function theory a geometric framework is established which allows to show that small amplitude viscous profiles are spectrally stable, i.e. the corresponding linearization along the wave has no eigenvalues λ with $Re(\lambda) \geq 0$, $\lambda \neq 0$. A suitable scaling brings out the slow-fast structure of the problem, which allows a precise description of the behaviour of the stable and unstable spaces in the small amplitude limit by using methods from invariant manifold theory.

In one space dimension the stability question of small amplitude genuine nonlinear k-shocks is reduced to the corresponding problem for a fixed shock of Burgers equation, which is known to be stable. The stability question for shocks associated with nonconvex or multiple modes is reduced to the stability of shocks of low-dimensional model problems. The stability of multi-dimensional shock waves is reduced to the condition that a certain "residual" Lopatinski-Kreiss-Majda determinant does not vanish, which is shown to be true under natural assumptions. This is joint work with H. Freistühler (Univ. Leipzig).

Applications of bifurcations to associative memory models

Gouhei Tanaka[a] and Kazuyuki Aihara[a,b]
[a]Institute of Industrial Science, The University of Tokyo, 153-8505, Tokyo, Japan
[b]ERATO Aihara Complexity Modelling Project, JST, 151-0065, Tokyo, Japan
e-mail: gouhei@sat.t.u-tokyo.ac.jp

In recent years, information processing using nonlinear phenomena has attracted much attention. In addition to synchronization of oscillators for communication systems and chaotic dynamics for cryptosystems, bifurcation phenomena are also candidates of techniques for efficient information processing. Desirable dynamics can be realized by exploring a specific type of bifurcation phenomenon.

In this talk, we consider associative memory models. A binary associative memory model such as the Hopfield neural network [1] is composed of elements encoding two states, while a multistate one such as the complex-valued neural network [2] consists of elements encoding multiple states. Binary associative memory models with the parametrically coupled sine map networks have been proposed by Lee and Farhat [3] by utilizing sine maps exhibiting distinctive bifurcation phenomena. We extended the binary models to multistate models by using circle maps and suitable coupling schemes [4].

We explain that the circle maps are explored to obtain desired bifurcation phenomena and the network configurations are adopted to realize desired network dynamics for associative memory. It is demonstrated that the circle map networks are capable of showing better associations of memories compared with the conventional multistate associative memory model, depending on a system parameter. Further, numerical results indicating interesting recall processes of the proposed networks are illustrated.

References:

[1] J. J. Hopfield. Neural networks and physical systems with emergent collective computational abilities, PNAS, 79, 2554-2558, 1982.

[2] S. Jankowski, A. Lozowski, and J. M. Zurada. Complex-Valued Mulstate Neural Associative Memory, IEEE Trans. On Neural Networks, 7(6), 1491-1496, 1996.

[3] G. Lee and N. H. Farhat. Parametrically coupled sine map networks, Int. J. Bifurcation Chaos Appl. Sci. Eng., 11(7), 1815-1834, 2001

[4] G. Tanaka and K. Aihara, Multistate associative memory with parametrically coupled map networks, Int. J. Bifurcation Chaos Appl. Sci. Eng., 15(4), 1-16, 2005.

Normal forms of the one-dimension DAEs with parameters

Yun Tang and Zhihui Yang
Department of Mathematical Sciences
Tsinghua University Beijing 100084, P.R.China

An equivalence is introduced among differential-algebraic equations(DAEs), which generalizes the Chua's equivalence of constraint equations into DAEs. In the sense of the equivalence, normal forms of the one-dimension DAE and phase diagrams with low dimension are given.

State-dependent delays, linearization, and periodic solutions

Hans-Otto Walther
University of Giessen, Germany

For differential equations with state-dependent delays, the initial value problem with data in open subsets of the familiar state spaces $C([-r,0],R^n)$ or $C^1([-r,0],R^n)$ is in general not well-posed. Under mild conditions on the equation, however, there is a submanifold of $C^1([-r,0],R^n)$ on which the IVP generates a semiflow F with continuously differentiable solution operators $F(t,\cdot)$ and further smoothness properties. This yields local invariant manifolds at stationary points and a convenient Principle of Linearized Stability, among others. The ad-hoc technique of freezing the delay and then linearizing the resulting equation with invariant delay, which has been successfully used by several authors for results related to linearization, is explained within the new framework.

As applications a Hopf bifurcation theorem for differential equations with state-dependent delay, due to Markus Eichmann, and a global result about existence of stable periodic orbits are presented, the latter for a system describing position control by echo.

Global Analysis of an SIS Epidemic Model with Periodic Parameters

Ladi Wang
Department of Applied Mathematics
Shanxi University of Finance and Economics
Taiyuan 030006
P. R. China
E-mail: wld58@126.com

In this paper, we considered an SIS epidemic model with periodic parameters, obtained the sufficient necessary condition which guarantees the uniqueness and existence of the periodic solution.

Essence and Characteristics of FM-DCSK Technique[8]

Lin Wang[1], Guanrong Chen[2]
[1] Department of Communication ENG., Xiamen University, Fujian 361005, China
[2]Department of Electronic ENG., City University Of Hong Kong, China

Frequency-Modulated Differential Chaos Shift Keying (FM-DCSK) is essentially a technique that combines modulation with a spreading spectrum property for communications. It is also an effective technique in a way similar to the recent multi-antenna methodology that can make use of multi-path effects thereby achieving excellent capability of anti-multi-path fading. Through analysis and simulation, this paper reports some essential characteristics and advantages in system performance of the newly proposed M-ary FM-DCSK technology. The basic design of the FM-DCSK-based chaotic spreading spectrum communication system and a comparison with its conventional equivalent are presented. It is shown that the former is not only robust in the

[8]Sponsored by the NSF of China (No.60272005), City Univ. of HK (No.9620004), and the program for NCET of University in China (No.NCET-04-0601)

multi-path fading environment and simple in implementation, but also flexible in adjusting system parameters and trading-off several effects among bandwidth efficiency, energy efficiency, data rate, and error performance. Finally the adaptability between FM-DCSK and Channel Coding schemes over fading channels is found. It is demonstrated that the FM-DCSK technique is promising in the next generation of wireless communication systems as an excellent candidate of modulation and spreading spectrum scheme.

Key words: Communication, M-ary FM-DCSK, anti-multipath, chaotic spreading spectrum scheme, bandwidth efficiency, energy efficiency, error performance, channel coding, fading channels

Synchronization of An Array of Linearly Coupled Networks with Time-varying Delay

Weiwei Wang and Jinde Cao
Department of Mathematics, Southeast University, Nanjing 210096, China
awei-awei@126.com; jdcao@seu.edu.cn

This paper studies the global exponential synchronization of the following system consisting of N linearly coupled neural networks with time-varying delay:

$$\frac{dx_i(t)}{dt} = -Dx_i(t) + Ag(x_i(t)) + Bf(x_i(t-\tau(t)) + I(t) + \sum_{j=1}^{N} c_{ij}\Gamma x_j(t),\ i = 1, 2, \cdots, N. \quad (0.9)$$

$C = (c_{ij})_{N\times N}$ is the coupling configuration matrix satisfying the following conditions:

$$\begin{aligned} c_{ij} &\geq 0,\ i \neq j, \\ c_{ii} &= -\sum_{j=1, j\neq i}^{N} c_{ij}. \end{aligned} \quad (0.10)$$

Throughout this paper we assume that:

(H_1) The activation functions $f_i(x_i),\ g_j(x_j), (i, j = 1, 2, \cdots, n)$ is Lipschitz continuous, that is, there exist constants $G_i > 0,\ F_j > 0$ such that

$$|g_i(x) - g_i(y)| \leq G_i|x - y|,\ |f_j(x) - f_j(y)| \leq F_j|x - y|,$$

(H_2) The delay is a nonnegative, bounded and continuous differentiable function defined on $\mathbb{R}^+$ and $\dot{\tau}(t) \leq \eta < 1$.

By using Lyapunov functional and linear matrix inequality (LMI) technique, a sufficient condition is derived for the global synchronization of system (1).

Theorem 1. Under the assumptions (H_1) and (H_2), and the coupling matrix C satisfies the condition (2). The dynamical system (1) is globally exponentially synchronized if there exist positive definite diagonal matrices $P = \text{diag}\{p_1, p_2, \cdots, p_n\} > 0$, $Q = \text{diag}\{q_1, q_2, \cdots, q_n\} > 0$, $\Sigma = \text{diag}\{\sigma_1, \sigma_2, \cdots, \sigma_n\} > 0$, a diagonal matrix $\Delta = \text{diag}\{\delta_1, \delta_2, \cdots, \delta_n\} \in \mathbb{R}^{n\times n}$ and an irreducible symmetric matrix $U = (u_{ij}) \in \mathbb{R}^{N\times N}$ satisfying condition (2), such that

$$\begin{pmatrix} -2(D+\Delta) + FQF + G\Sigma G & PA & PB \\ A^T P & -\Sigma & 0 \\ B^T P & 0 & -(1-\eta)Q \end{pmatrix} < 0, \quad (0.11)$$

and

$$\{U(\gamma_i C + \delta_i I_N)\}^s \geq 0, \tag{0.12}$$

hold for $i = 1, 2, \cdots, n$, where $G = \text{diag}\{G_1, G_2, \cdots, G_n\} > 0$, $F = \text{diag}\{F_1, F_2, \cdots, F_n\} > 0$, $A^s = \frac{1}{2}(A + A^T)$ is the symmetric part of A.

Based on [1] and [2], a sufficient condition is obtained ensuring that system (1) is global exponential synchronization, and the obtained result improves those in [2].

References

[1] C. W. Wu, L. O. Chua. Synchronization in an array of linearly coupled dynamical system. IEEE Trans. Circuit Syst. I, 42 (8) (1995), 430-447.

[2] W. L. Lu, T. P. Chen. Synchronization of coupled connected neural networks with delays. IEEE Trans. Circuits Syst. I, 51 (12) (2004), 2491-2503.

Nonlinear Dynamical and Bifurcation Solution for Rotation of Triaxial Body

Wen-Jun WANG

Institute of Geodesy and Geophysics
Chinese Academy of Sciences
Wuhan 430077
P. R. China

A triaxial body rotating about a fixed point is formulated with inertia momenta of three principal directions. The exact solution for rotation of triaxial body should be expressed as elliptic functions but as inexplicit functions the feature of the solution cannot be obtained clearly. By decomposition it is expressed as direct product of three single pendulums with two stable trajectories that may interact relatively with subharmonic resonance. Also there are bifurcation solutions in the system as excitation existing. The unstable solution about the medium inertia momentum axis provides one-way pendulum solution that may cause the body rotating up side down. All the solutions are discussed in reality respect to Earth rotation as examples identical to the observation.

CARRYING SIMPLICES IN DISCRETE COMPETITIVE SYSTEMS AND AGE-STRUCTURED SEMELPAROUS POPULATIONS

Odo Diekmann and Yi Wang

University of Turku, Finland

For the discrete competitive systems, we give the amenable conditions guaranteeing the existence of an invariant attracting hypersurface Σ, called carrying simplex. We further consider a class of nonlinear Leslie matrix models for age-structured semelparous populations, in which competitive interaction between individuals is modelled via one-dimensional environmental quantity. We show this model has a carrying simplex Σ and formulate some open problems concerning normal hyperbolicity of Σ, heteroclinic boundary cycle and global behavior in semelparous populations.

Chaotic synchronization in coupled map lattices

Yiqian Wang
Department of Mathematics
Nanjing University
Nanjing, P. R. CHINA
E-mail: yqwang31415926@yahoo.com.cn

Synchronization is often found in the systems coupled by many identical sub-systems. When synchronization occurs, the behaviors of the sub-systems tend to each other as time goes to infinity. In many models, such as cell diversification, epilepsy, secure communication, etc, synchronization plays a key role. In this talk, we will introduce the mechanism of Chaotic synchronization in coupled map lattices and its applications in the systems stated above.

On the Study of Singularities for a Magnetic Bearing System with Time Delay[9]

Junjie Wei and Weihua Jiang
Department of Mathematics
Harbin Institute of Technology
Harbin 150001
P. R. China

A kind of magnetic bearing system with time delay is considered. Firstly, The zero eigenvalue and purely imaginary eigenvalues for the linearization of the system near the trivial equilibrium is addressed. Then the center manifold reduction and normal form computation for simple zero and a pure imaginary pair of eigenvalues singularity are performed and detailed bifurcation analysis are carried out. Finally, some numerical simulations are carried out to illustrate the results found.

Key words: Magnetic bearing system; time delay; singularity; bifurcation; normal form.

Positive periodic solution of a compound discrete predater-prey system on patches with Holling-(m+1) type functional response

Shuyuan Shen, Peixuan Weng
School of Mathematical Sciences
South China Normal University
Guangzhou 510631, China

Recently, many articles are published for ordinary differential equations with impulses, and some people try to discuss the difference equations with impulses. But in fact, what they discussed are totally different with the real impulsive phenomena in the continuous situation. We found that for the discrete systems, at so called impulsive instants, the Δ step difference operator has different definition with that for so called non-impulsive instants, thus we think it is better to call this kind of system as a compound difference system.

[9]Supported by the National Natural Science Foundation of China.

Let $\mathbf{Z}$ denote the set of the integer, $\mathbf{N} = \{0, 1, 2, 3, \cdots\}, \mathbf{N}^+ = \{1, 2, 3 \cdots\}, I_\omega = \{0, 1, 2, \cdots, \omega - 1\}, \omega \in \mathbf{N}^+$. In this paper , we establish a compound discrete predator-prey model which possesses diffusions and $Holling - (m+1)(m > 2)$ type functional response as follows:

$$\begin{cases} u_i(n+1) = u_i(n)\exp\{r_i(n) - a_i(n)u_i(n) - \frac{\alpha_i(n)u_i^{m-1}(n)v_i(n)}{1+\beta_i(n)u_i^m(n)} \\ \qquad + \frac{1}{u_i(n)}\sum\limits_{j=1}^{n^*}[D_{ij}(n)u_j(n) - D_{ji}(n)u_i(n)]\}, \\ v_i(n+1) = v_i(n)\exp\{\overline{r}_i(n) - \overline{a}_i(n)v_i(n) + \overline{c}_i(n)\frac{\alpha_i(n)u_i^m(n)}{1+\beta_i(n)u_i^m(n)} \\ \qquad + \frac{1}{v_i(n)}\sum\limits_{j=1}^{n^*}[\overline{D}_{ij}(n)v_j(n) - \overline{D}_{ji}(n)v_i(n)]\}, \qquad n \neq n_k, n \in \mathbf{N}. \\ u_i(n_k+1) - u_i(n_k) = \psi_k(u_i(n_k)), \\ v_i(n_k+1) - v_i(n_k) = \varphi_k(v_i(n_k)), \qquad n = n_k, k \in \mathbf{N}^+, \end{cases} \tag{1.1}$$

where $u_i(n), v_i(n)$ represent the prey population and the predator population in the ith patch respectively. We suppose that the number of the harvesting (or stocking) is l in an ω-period. $\psi_k(u_i(n_k))$ and $\varphi_k(v_i(n_k))$ represent the harvesting capacity of species U and the stocking capacity of species V in the ith patch at time n_k, respectively. When $\psi_k(u_i(n_k)) > 0$, it stands for harvesting, while $\varphi_k(v_i(n_k)) < 0$ it means stocking. By using Gains and Mawhin coincidence degree, Sufficient conditions are derived for the existence of periodic solution of (1.1).

Bifurcations in a nonsmooth system [10]

Zhiqiang Wu
Department of Mechanics, Tianjin University, Tianjin, P. R. China, 300072
Email Address: zhiqwu@tju.edu.cn

This paper is to investigate periodic bifurcation solutions of a mechanical system which involves a von der Pol type damping and a hysteretic damper representing restoring force. This system has recently been studied based on the singularity theory for bifurcations of smooth functions. Thus, the results do not actually take account of the property of non-smoothness involved in the system. In particular, the transition varieties due to constraint boundaries were ignored, resulting in failure in finding some important bifurcation solutions. To reveal all possible bifurcation patterns for such systems, a new method is developed. With this method, a continuous, piecewise smooth bifurcation problem can be transformed into several sub-bifurcation problems with either single-sided or double-sided constraints. Further, the constrained bifurcation problems are converted unconstrained problems and then singularity theory is employed to find the transition varieties. The explicit formulas are then applied to analyze the mechanical system. Numerical simulations are carried out to verify the analytical predictions. Moreover, symbolic notation for sequence of bifurcations is introduced to make it easy in showing the characteristics of bifurcations and the comparison of different bifurcations. The method developed in this paper can be easily extend to study bifurcation problems with other types of non-smoothness.

Keywords: constraint bifurcation, singularity theory, constraint

[10]The project was supported by the NSFC (No.10102014, 10472078).

Hyperbolicity, invariant sets with positive measures and ergodicity

Zhihong Xia
Department of mathematics, Northwest University, USA
email: xia@math.northwestern.edu

Bifurcations in a predator-prey system of Holling type-IV and Leslie type

Yilong Li and Dongmei Xiao
Department of Mathematics
Shanghai Jiao Tong University
Shanghai 200240, P. R. China

A predator-prey system with simplied Holling type-IV functional response and predator's numerical response is considered. The bifurcation analysis of the model depending on all parameters indicates that it exhibits numerous kinds of bifurcation phenomena, including the supercritical and subcritical Hopf bifurcations, Bogdanov-Takens bifurcation of codimension 2, and Bogdanov-Takens bifurcation of codimension 3. It is shown that there are di?erent parameter values for which the model has one or two limit cycle and computer simulation are presented to illustrate the conclusions.

Key words: A predator-prey system, Hopf bifurcations, Bogdanov- Takens bifurcations, limit cycles.

The stability and bifurcation of a stochastically dynamical business cycle model

Wei Li, Wei Xu[11] Junfeng Zhao and Yanfei Jin
Department of Applied Mathematics
Northwestern Polytechnical University
Xi'an, Shaanxi 710072
P. R. China

Based on the ideas of Goodwin's consumption function and Puu's investment function, a new dynamical business cycle model is proposed, in which a two-order stochastic dynamical system by introducing a stochastic autonomous function is to be investigated. The resulting dynamical system is too complex to be completely understood and solved by means of deterministic dynamical system tools, so we turn to use the stochastic averaging method of quasi-non-integralbe Hamiltonian system. The stability and bifurcation of the stochastically dynamical business cycle model are examined theoretically and numerically, and illustrative figures are presented to show the excellent agreement between theoretical and numerical results.

Keywords: Business cycle; Macroeconomics; Quasi-non-integrable Hamiltonian system; stochastic averaging method; Hopf bifurcation

[11]Corresponding author: Tel.: +86-29-884-95-453; fax: +86-29-884-95-453
E-mail addresses: liwei@mail.nwpu.edu.cn (W. Li) weixu@nwpu.edu.cn (W. Xu)

Bifurcation analysis of travelling wave solution for the Generalized Korteweg-de Vries equations

Jianwei Shen[a,b], Wei Xu[a]

[a] [12]Department of Applied Mathematics, Northwestern Polytechnical University, Xi'an, Shaanxi 710072, P. R. China

[b] Department of Mathematics, Xuchang University, Xuchang, Henan 461000, P.R.China

In this paper, we consider a new generalization of KdV equation based on a fist-order Lagrangian formulation, and investigate its bifurcation of travelling wave solutions. From the above analysis, we can know that there exists compacton and peakon in the system. we explain the reason that these non-smooth travelling wave solution arise from the bifurcation theory. In the meantime, we give the exact solutions corresponding to different bifurcation regions by using direct integral and Ansatz with Wu elimination method. In the end, simulation results explicit the rightness of above analysis.

Key Words: travelling wave solution, smoothness of waves, bifurcation theory, compacton, peakon, Wu elimination,

PACS numbers: 02.30.Oz, 02.30.Ik, 03.65.Ge, 02.30.Hq.

Synchronization of two Ginzburg-Landau equations using local copling

Zhenyuan Xu

School of Science

Southern Yangtze University

Wuxi 214112, Jiangsu

P. R. China

The complete synchronization of two Ginzburg-Landau equations using local coupling (sensers) is proved on the theory. Our results are identity with the results of V.Parlitz 'numerical results. Consider the following one -dimensional complex Ginzburg-Landau equation:

$$\frac{\partial u}{\partial t} = \mu u - (k + i\beta_1)|u|^2 u + (\lambda + i\alpha)\Delta u \quad x \in [0, L] \tag{1}$$

with periodic boundary conditions.

The driven system is:

$$\frac{\partial v}{\partial t} = \mu v - (k + i\beta_1)|v|^2 v + (\lambda + i\alpha)\Delta v + f(\widetilde{u}_n, \widetilde{v}_n) \tag{2}$$

with periodic boundary conditions. Where

$$f(\widetilde{u}_n, \widetilde{v}_n) = \begin{cases} \varepsilon(\widetilde{u}_n - \widetilde{v}_n) & nd - \frac{l}{2} \le x \le nd + \frac{l}{2} \\ 0 & elsewhere \end{cases}$$

$$\widetilde{u}_n(t) = \frac{1}{l}\int_{nd-\frac{l}{2}}^{nd+\frac{l}{2}} u(x,t)dt, \quad n = 1, 2, \ldots N$$

[12]Corresponding address

Tel:+86-29-88495453, Fax:+86-29-88495453

E-mail addresses: jwshen@mail.edu.cn(J. Shen), weixu@nwpu.edu.cn (W. Xu)

On Physical Review E 61 (4) 2000 U. Parlitz proved that (1), (2) can realize the complete synchronization using numerical investigation.

In this paper we have obtained that:

(1) The solutions u(t),v(t) of (1),(2) has a global attractor.

(2) (1), (2) can realize the compete synchronization.

(3) The analytic expressions of estimate for Lyapunov exponents are obtained.

Key words: synchronization, local coupling Ginzburg-Landau equation, attractor, Lyapunov exponents.

On the Hamiltonian structure of normal forms for elliptic equilibria of reversible vector fields in R^{2n}

Jiazhong Yang
School of Mathematical Sciences
Peking University
Beijing, China

It is well-known that many important theorems which hold for the Hamiltonian vector fields have their counterpart in the reversible category, e.g. the KAM theorem, the Lyapunov center theorems, etc. In my talk, I will explain, mainly from normal form point of view, resemblance and the difference of dynamics between these two contexts. More precisely, given a vector field with a fixed linear approximation, we shall derive and compare the normal forms of the vector field respecting extra symmetries, e.g. reversibility, symplectic structure, reversible symplectic structure, etc. The discussion will be primarily focused on R^{2n}, where all the objects are assumed to have an equilibrium at 0 and the linearized systems have n pairs of purely imaginary eigenvalues. The latter assumption is generic in the class of all reversible vector fields on $\mathbf{R}^{2n}$. The equivalence categories we adopt in this paper are formal conjugacy and formally orbital equivalence.

Monotone Functionals and Oscillation of Self-Adjoint Matrix Hamiltonian Systems[13]

Qigui Yang
Department of Mathematics
South China University of Technology
Guangzhou, 510640 China
E-mail: yangqigui@263.net

Monotone functional is introduced to handle matrix Hamiltonian systems for the first time, and used to study their oscillatory behaviors. In particular, a class of self-adjoint Hamiltonian matrix differential systems are discussed. By means of generalized matrix Riccati transformations, monotone functionals (involving positive linear functionals and the spectral functionals of Hermitian matrices, we employ as tools monotone functional), functions $H(t,s)k(s)$ and $\Phi(t,s,r)$ that may not have a nonpositive partial derivative with respect to the second variable, the averaging technique, and various inequalities, we obtain some new oscillation criteria based on information available on the half-line, and in addition interval oscillation criteria based on the information only on a sequence of subintervals of $[t_0,\infty)$. Our conclusions are new even if the systems become second

[13]Project 10461002 supported by NSFC

order ordinary differential equations, and moreover some of our conclusions are sharp. In addition, by choosing specific monotone functionals, functions $H(t,s)$, $\Phi(t,s,r)$ and $k(s)$, we are able to present a series of explicit oscillation criteria. Furthermore, our results improve, extend, unify and complement a number of known results. Some important problems are also solved. Examples are also included for illustration.

Keywords: Matrix Hamiltonian System; Monotone Functional; Oscillation; Generalized Riccati Transformation.

Mathematics Subject Classifications: 34A30, 34C10

The Chaotic Motions in a Vehicle Suspension System with Magnetorheological Fluid Damper

Shuqi Guo[a], Shaopu Yang[b] and Cunzhi Pan[a]

[a] School of Mechanical, Electronic and Control Engineering, Beijing Jiaotong University, Beijing 100044, China

[b] Shijiazhuang Railway Institute, Shijiazhuang 050043, China.

E-mail: shuqig@yahoo.com.cn; yanngsp@sjzri.edu.cn; panczh@sjzri.edu.cn

The paper presents the investigation on chaotic motion in a quarter car suspension system with magnetorheological fluid damper, which is subjected to the harmonic excitation from road surface. The path from quasi-periodic to chaotic motion is found via Poincare map. The suspension system is semi-active suspension with skyhook controlled magnetorheological (MR) damper.

The concept of skyhook controlled damping for semi-active vibration control originated from Karnopp's studies. A skyhook controlled damping system consists of a fictitious damper, a sprung mass and an absolute reference frame (fixed in the sky). The fictitious "skyhook" damper provides a controlled damping force for the vibration reduction of the sprung mass. Semi-active vibration control has recently become possible with the advent of powerful but relatively inexpensive signal processors and actuators. Magneto-rheological fluid (MRF) dampers are a class of semi-active devices that have been receiving attention in vibration control applications and are ideally suited for semi-active skyhook control.

A typical quarter car suspension system with MR damper under skyhook control is given as Eqs. (1), and (2).

$$m_s\ddot{z}_s + k_s(z_s - z_u) + F_{md} = 0 \tag{1}$$

$$m_u\ddot{z}_u + k_s z_u + k_t z_u + c_1\dot{z}_u = k_t z_r + k_s z_s + c_1\dot{z}_r \tag{2}$$

where m_s denotes sprung mass, m_u unsprung mass, k_s suspension stiffness, k_1 tyre stiffness , c_1 the damping coefficient of the tyre, $z_r$road excitation, $F_{md}$the damping force of MR damper that is described by the nonlinear bi-viscous and hysteretic model, i.e. Eq. (3).

$$F_{md} = A_1 \tanh(\dot{z}_s + z_s\omega\tan\theta_0) + A_2(\dot{z}_s + z_s\omega\tan\theta_0) \tag{3}$$

Let$m_s = 240kg$, $m_u = 36kg$, $k_s = 16000N/m$, $k_t = 16000N/m$,$A_1 = 1500N$, $A_2 = 600N\cdot s/m$, $\theta_0 = 0.9$, $c_1 = 500N\cdot s/m$, $a = 0.5m$, road excitation$z_r = a\sin\omega t$, chaotic field$\omega \in [30, 76]$, the chaotic motion is found by numeric simulations. It is presented as Figs.1, 2 that the poincare map and phase diagram for $\omega = 60.81$.

More results about the effects of parameters of the damper on the chaotic field are obtained.

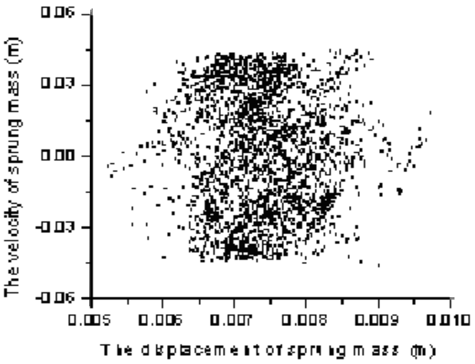

Figure 1: The poincare map

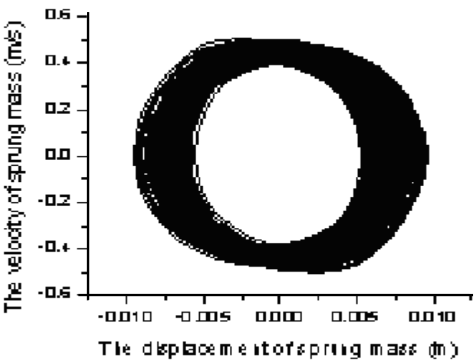

Figure 2: The phase diagram

The existence of integrable invariant manifolds of Hamiltonian partial differential equations

Jiangong You
Department of Mathematics
Nanjing University
Nanjing, China
E-mail: jyou@nju.edu.cn

In this talk, it is shown that some Hamiltonian partial differential equations such as semi-linear schrödinger equations, semi-linear wave equations and semi-linear beam equations are partial integrable, i.e., they possess integrable invariant manifolds foliated by invariant tori which carry periodic or quasi-periodic solutions. The linear stability of the obtained invariant manifolds is also concluded. The proofs are based on a special invariant property of the considered equations and a symplectic change of variables.

Multiple-Spike Ground State Solutions of the Activator-Inhibitor Equations

Yuncheng You
Department of Mathematics
University of South Florida
Tampa FL 33620, USA
Tel. (813)-974-9741
Fax. (813)-974-2700
Email: you@math.usf.edu

In many biological pattern formation and in some chemical or biochemical reactions such as autocatalysis, an activator-inhibitor system of PDEs serves as a mathematical model, typically, the Gierer-Meinhardt system. This system features two largely different diffusion coefficients and an essentially nonlocal nonlinearity. By the Lyapunov-Schmidt method, the order estimate of multiple spikes of the ground state solutions are made with the construction of these solutions.

Boundary value problems of discrete generalized Emden-Fowler equation

Jianshe Yu
School of Mathematics and Information Sciences
Guangzhou University, Guangzhou, 510405
P. R. China

By using the critical point theory, some sufficient conditions for the existence of solutions to the boundary value problems of a discrete generalized Emden-Fowler equation are obtained. In a special case, a sharp condition is obtained for the existence of the boundary value problems of the above equation. For the linear case, by discrete variational theory, necessary and sufficient conditions are also established for the existence, uniqueness and multiplicity of solutions.

Bifurcation of Limit Cycles and Hilbert's 16th Problem

Pei Yu
Department of Applied Mathematics
The University of Western Ontario
London, Ontario, Canada N6A 5B7
pyu@pyu1.apmaths.uwo.ca

In this talk, we present some new results on the study of the second part of Hilbert's 16th problem. After a brief review of the problem, two particular cases will be discussed. The first case is for cubic order Z_2-equivariant vector fields. Local bifurcation analysis using normal form theory shows that a cubic order Z_2-equivariant vector field can have 12 limit cycles, i.e., $H(2) \geq 12$. The second case is for the weakened Hilbert's 16th problem in the study of higher-order perturbed polynomial Hamiltonian systems. The attention here is focused on rarely considered even order systems. With the aid of the detection function method and normal form theory, both global and local bifurcation analyses are employed to show that a quintic Hamiltonian system under a 6th-order perturbation can generate at least 35 limit cycles, i.e., $H(6) \geq 6^2 - 1$. Combining this result with our other new results: $H(9) \geq 9^2 - 1$, $H(11) \geq 11^2$, as well as the existing results: $H(2) \geq 4$, $H(4) \geq 4^2 - 1$, $H(5) \geq 5^2 - 1$, $H(7) \geq 7^2$, a conjecture is posed for Hilbert's 16th problem: $H(n) \geq n^2$ or $n^2 - 1$. (Collaborators: S. Wang, M. Han and J. Li.)

Quasi-periodic solutions of nonlinear wave equations via KAM theory

Xiaoping Yuan
School of Math.
Fudan University
Shanghai 200433, PRC

In this talk, we will give three announcemens:1. There are many quasi-periodic solutions for NLW with a prescribed potentail (Preprint FIDM 04-11); 2. There are many quasi-periodic solutions for completely resonant NLW (Preprint FIDM 04-12), this answers an open problem by Kuksin, Bourgain and Yoccoz,etc.; 3. 2. There are many quasi-periodic solutions for NLW and NLS of higher spatial dimension,this answers an open problem by Kuksin, Bourgain , etc.

Synchronization in a Delayed-Neural Network with Symmetry of the Square

Yuan Yuan
Department of Mathematics and Statistics
Memorial University of Newfoundland
St. John's, Newfoundland, Canada A1C 5S7

In this talk, we consider a neural network of four symmetric identical neurons with time-delayed connections. Some parameter regions are given for global, local stability and synchronization with the help of Liapunov functionals and the root distributions in the corresponding characteristic transcendental equation. Hopf and equivariant Hopf bifurcations are investigated using bifurcation theory and numerical simulations.

Perturbations to homoclinic orbits for conservative systems

Chongchun Zeng
Virginia University, USA

Given a dynamical system with a conserved quantity and a homoclinic orbit to a saddle-center fixed point, we consider the defomration of the homoclinic orbit under small conservative perturbations. The Melnikov integral usually vanishes in this situation. Under certain nondegeneracy conditions and a rather general assumption that the Hessian of the conserved quantity at the fixed point is positive definite in the center directions, we prove that orbits homoclinic to center manifolds persists. Applications to nonlinear wave equations will be discussed.

Exact 2- and 3-periodic traveling solutions for a class of partial difference equations

Guang Zhang
Department of Mathematics
Qingdao Technological Universiy
No. 11, Fushun Road
Qingdao 266033, CHINA
E-mail: qd_gzhang@126.com or shzhg@qtech.edu.cn

Recently, the existence of periodic traveling solutions for partial difference equations or coupled map lattices (CLMs) has been extensively studied by a number of authors in theory proofs and numerical experiments. However, we have no seen any result for the existence of exact solutions. Such solutions are important and have been much studied for PDEs.

In this talk, we will introduce the existence of exact 2-periodic and 3-periodic generalized traveling wave solutions by using Maple. Particularly, the bifurcation values of 2-periodic and 3-periodic generalized traveling wave solutions will be exactly given.

AMS Subject Classification: 39A10.

Keywords: Partial difference equation, coupled map lattice, traveling wave solution, exact solutions, Maple.

Study Strongly Autonomous Nonlinear Vibration System with Two Degrees of Freedom by Normal Form Method

Wei Wang and Qi-Chang Zhang
School of Mechanical Engineering
Tianjin University, Tianjin 300072
P. R. CHINA

The method of undetermined solving frequency method[1] is developed to study the strong nonlinear vibration system with two-degree-freedom. There are many approximate methods to deal with weakly nonlinear vibration problems, such as the methods of multiple scales, averaging, normal form, Lindstedt-Poinscar and so on. However for the strongly nonlinear vibration system, the study is nearly still at its initial stage. There are stroboscopic method[2]modified approximate method[3]modified elliptic Lindstedt-Poincar method[4] and normal form method[1] etc. In reference [2, 3, 4], authors always introduced a new small parameter to substitute in the equations and changed the system of strongly nonlinear oscillations into a weakly one. In reference[1], authors chose the response frequency by considering the change of the fundamental frequency during the course of vibration to resolve the single degree of freedom system with a new frequency. In this article, we developed reference [1]'s method to a broad range. First we researched a cubic order nonlinear system with two degrees of freedom. Then we selected a higher order near-identity nonlinear transformation than Nayfeh's former theory [5]. Here the new five order transformation was introduced to acquire the normal form of the cubic order nonlinear system, therefore we might obtain more exact value of and , as well as the coefficients of normal form and nonlinear transformation during the course of calculation. At the end, we compared the asymptotic solutions obtained by present method and Nayfeh's former theories for Duffing-Van der Pol oscillator with strongly nonlinearity, which justified the veracity of present method.

References

[1] Zhang Qichang. Complex Normal form for strongly nonlinear vibration systems exemplified by Duffing-Van der Pol equation. Journal of Sound and Vibration, 1998213(5)907914

[2] Li Xue-ping, Tang Jiashi. The approximately analytical method for strongly nonlinear systems with mult-degree of freedom, Journal of Changsha railway university, 200018(2)8083

[3] Yuan Yi-wu, Solving strongly nonlinear oscillation problem of conservative system by using linearization and interpolation perturbation methods, Journal of Chongqing Jiao tong
university, 2004, 23(6): 128131

[4] Yang C H, Zhu S M, Chen S H. A modified elliptic Lindstedt-Poincar method for certain strongly non-linear oscillator, Journal of Sound and Vibration, 2004, 273(4): 921932

[5] Nayfeh A H. Method of Normal forms, New York : John Wiley and Sons, 1993

[6] Li Li. The Qualitative Analysis and the Quantitative Method for Strongly Nonlinear Systems, Beijing: Science Press, 1996

This work is supported by NNSF of China (Grant number: 10372068)

Periodic Solutions for Some Newtonian n-Body Problems

Shiqing Zhang
Department of Mathematics, Yangzhou University
Yangzhou, Jiangsu, P.R.China , zhangshiqing@msn.com

A New Multi-Pulse Chaotic Motion for Parametrically Excited Viscoelastic Axially Moving String

Wei Zhang[14] and Minghui Yao
College of Mechanical Engineering, Beijing University of Technology
Beijing 100022, P. R. China

In this paper, the Shilnikov type multi-pulse orbits and chaotic dynamics of parametrically excited viscoelastic moving string are studied in detail. Using Kelvin-type viscoelastic constitutive law, the equation of motion for viscoelastic moving string with the external damping and parametric excitation is given. The four-dimensional averaged equation under the case of 1:1 internal resonance and primary parametric resonance is obtained by directly using the method of multiple scales and Galerkin's approach to the partial differential governing equation of viscoelastic moving string. The Shilnikov type multi-pulse chaotic motions of viscoelastic moving string are also found by using numerical simulation. A new phenomenon on the multi-pulse jumping orbits and a new strange attractor are observed from three-dimensional phase space for the first time.

Key words Viscoelastic moving string, parametric excitation, multi-pulse chaotic motion

On exact Poisson structures

Xiang Zhang
Shanghai Jiaotong University
Shanghai, China
(Joint work with Yingfei Yi)

By studying the exactness of multi-linear vectors on a smooth manifold **M**, we give characterizations to exact Poisson structures defined on **M** and study general properties of these structures. Following some recent works, we will pay particular attention to the classification of some special classes of exact Poisson structures such as Jacobian and quasi-homogeneous Poisson structures. A characterization of exact Poisson structures which are invariant under the flow of a class of completely integrable systems will also be given.

Stochastic resonance and Brownian ratchet: dynamical illustration and nonequilibrium interpretation

Xue-Juan Zhang
Mathematical Department of Shaoxing University
Zhejiang Province 312000, P. R. China
E-mail: zxj@zscas.edu.cn

This talk reports our recent works of stochastic resonance (SR) and Brownian ratchet (BR) in nonlinear stochastic systems. The topic is to present a unifying dynamical as well as statistical framework for SR and BR. Based on embedding the system into a higher dimensional space, it is shown that for periodically driven systems, the occurrences of SR and BR are both ascribed to the noise-induced switching between stable limit cycles which lie at a relatively favorable position to

[14]Corresponding Author. Email: sandyzhang0@yahoo.com

the unstable limit cycle. We further manifest that the physical essence underneath is due to the existence of nonequilibrium circulation.

Keywords: Stochastic resonance; Brownian ratchet; limit cycle; power spectrum; mean mobility; nonequilibrium circulation.

Asymptotic Speeds of Spread and Traveling Waves for Monotone Semiflows with Applications

Xiaoqiang Zhao
Department of Mathematics and Statistics
Memorial University of Newfoundland
St. John's, NL A1C 5S7 Canada

The theory of asymptotic speeds of spread and monotone traveling waves is established for a class of monotone discrete and continuous-time semiflows and is applied to a functional differential equation with diffusion, a time-delayed lattice population model and a reaction-diffusion equation in an infinite cylinder. This talk is mainly based on a recent joint work with Dr. Xing Liang.

Perturbations of non-Hamiltonian reversible quadratic systems with cubic orbits[15]

Yulin Zhao
Department of Mathematics
Sun Yat-sen University
Guangzhou, 510275, P.R.China
E-mail: mcszyl@zsu.edu.cn

This paper is concerned with polynomial perturbations of a class of planar non-Hamiltonian reversible quadratic integrable system whose almost all orbits are cubics. We give an estimate of the number of limit cycles for such system. If the first order Melnikov function (Abelian integral) $M_1(h)$ is not identically zero, then the perturbed system has at most 5 for $n = 3$ and $3n - 7$ for $n \geq 4$ limit cycles on the finite plane. If $M_1(h)$ is identically zero but the second Melnikov function is not, then an upper bound for the number of limit cycles on the finite plane is 11 for $n = 3$ and $6n - 13$ for $n \geq 4$, respectively. In the case when the perturbation is quadratic ($n = 2$), there exist a neighborhood $\mathcal{U}$ of the initial non-Hamiltonian polynomial system in the space of all quadratic vector fields such that any system in $\mathcal{U}$ has at most two limit cycles on the finite plane. The bound for $n = 2$ is exact.

Key words: The k-th order Melnikov function, limit cycles.
AMS subject (2000): 34C07, 34C08, 37G15,34M50.

[15]Supported by Guangdong Natural Science Foundation (No. 04009794).

Synchronization in lattices of coupled nonlinear and non-autonomous equations

Shengfan Zhou
Department of Mathematics
Shanghai University
Shanghai 200444
People's Republic of China
E-mail: sfzhou@mail.shu.edu.cn

We consider a general mathematical framework of the synchronization and approximate synchronization between any two solutions and any two components of solutions for m-dimensional lattices of coupled nonlinear equations with external forcing terms under the assumption of point (bounded) dissipativeness of solutions. We prove that if the coupled coefficients are large enough, the synchronization between any two solutions and the approximate synchronization between any two components of solutions occur for coupled non-identical equations, and the synchronization between any two components of solutions occur for coupled identical equations, here the eigenvalues of coupled operators play an essential role. We consider in detail the bounded dissipativeness and synchronization of solutions in lattices of coupled m-dimensional non-autonomous Lorenz equation, we give the bounded dissipative conditions of solutions with an absorbing set depending on the coupling coefficients and independent of the coupling coefficients. Finally, we show that the synchronization of solutions for the coupled identical Lorenz equation can be slaved by the coefficient in x or y-component. Our results show that the bound controlling the synchronization of solutions is direct proportion to the number n^m of lattice points and inverse proportion to the coupled coefficients, where n is the mesh size and m is the space dimension of lattice points.

Excitation Functions of Coupling

Tianshou Zhou
Department of Mathematics and Computational Sciences
Zhongshan University
Guangzhou 510275, P.R. China.
E-mail: mcszhtsh@zsu.edu.cn

The responses of nonlinear systems of two classes to coupling are investigated. It is shown both analytically and numerically that coupling has an excitation ability in a network of the linearly coupled systems. That is, when an uncoupled system is degenerated to a stable steady state from a limit cycle but in the "marginal" state due to the system parameter, an appropriate coupling strength can excite the limit cycle such that the coupled systems exhibit synchronous oscillation; when the uncoupled system is in a stable limit cycle but close to a chaotic attractor, a certain coupling strength can induce the chaotic attractor such that the coupled systems reach chaotic synchronization. Such excitation functions of coupling are different from its traditional role where coupling mainly synchronizes the coupled systems with the original dynamics of the uncoupled system.

Stability of C^0 Semigroups Which Possess Global Attractor

Yunhua Zhou

Let $Sg(M)$ be a set of all the continuous semigroups in a Banach space M, endowed with C^0 topology. X represents all the C^0 semigroups which possess lobal attractors in M. A C^0 semigroup $\{S(t)\}_{t\geq 0} \in \mathcal{X}$ is called stable, if there is a C^0 ε-neighborhood U of $\{S(t)\}_{t\geq 0}$, such that $\mathcal{U} \subset \mathcal{X}$. Using the measure of noncompactness, we prove the continuous semigroup which possesses the global attractor is in general not stable.

The Existence of Periodic and Subharmonic Solutions to Subquadratic Discrete Hamiltonian Systems

Zhan Zhou Jianshe Yu Zhiming Guo
School of Mathematics and Information Sciences, Guangzhou University
Guangzhou 510405, People's Republic of China
E-mail: zhou-zhan@163.net

In this talk, by using critical point theory, we will obtain some results for the existence of periodic solutions and subharmonic solutions to the discrete Hamiltonian systems

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

where $x_1, x_2 \in \mathbf{R}^d$, $H(n, x_1, x_2) \in C^1(\mathbf{R}^d \times \mathbf{R}^d, \mathbf{R})$ for each $n \in \mathbf{Z}$.

CODIMENSION 3 BIFURCATIONS OF HETEROCLINIC LOOP CONTAINING TWO SADDLE-FOCI

Guifeng Deng and Deming Zhu
Department of Mathematics
East China Normal University
Shanghai, CHINA

The codimension 3 bifurcations associated with a heteroclinic loop formed with two saddle-foci (one has a pair of image eigenvalues) and two of their heteroclinic orbits are considered in the 3-dimensional space. It is proved that, in a neighborhood of the heteroclinic loop, there are countably infinite 1-homoclinic orbits and 1-heteroclinic orbits. Meanwhile, under a transversal condition, the existence of infinitely many heterclinic orbits joining two saddle-foci, 1- and 3/2-heterclinic loops connecting a sddle-focus and a limit cycle produced from Hopf bifurcation, and 1-homoclinic orbits approaching the limit cycle or a sddle-focus are obtained, and the bifurcation surfaces and the existence regions are also given.

Advance on Qualitative Analysis and Stability for Dynamic Equations on Time Scales

Siming Zhu YanHui Li[16]
Department of Mathematics
Sun Yat-Sen University
Guangzhou 510275, China

The calculus on measure chains, introduced by the German mathematician S. Hilge in 1988 in his doctor dissertation, was intended to unify the analysis of differential equations and difference equations. As a representative case, Time scale($\mathbb{T}$) is meant to any nonempty closed subset of $\mathbb{R}$, for exmaple, $\mathbb{R}$, $\mathbb{Z}$, *Cantor* etc.. The time scales theory has been developed further by M.Bohner and other interested scholars, and meanwhile its potential applications in biology, epidemiology, networks and etc. make the theory develop rapidly and attract a lot of focus in the world.

This paper will firstly introduce some current results on the stability of dynamic equations on several types of special time scales. The homogeneous time scales ($\mu(t) = h(\text{constant})$) and a periodic time scales are made detailed analysis. The stability of trivial solution for the first-order linear and nonlinear dynamic equations is discussed.

Then for the planar linear dynamic equations with constant coefficients, the qualitative structure of equilibrium is introduced on the homogenous time scales and the periodic time scales.

For the n dimentional dynamic equations on time scales, making use of the Liapunov function on time scales, we study the criteria of local and global stability. Considering the various kinds of definitons for exponential stability, we discuss the relationship among them. At last the stability on partial variables and robustness are also presented.

Stochastic Bifurcation of Quasi Hamiltonian Systems

Weiqiu Zhu
Department of Mechanics
Zhejiang University
Hangzhou 310027
P. R. China

The presentation consists of four parts. Part one is brief introduction to stochastic stability, focusing on determining the asymptotic stability with probability one by using the largest Lyapunov exponent and determining the asymptotic stability in probability of one dimensional diffusion process by its boundary classification. Part two is brief introduction to stochastic bifurcation including dynamical bifurcation (D-bifurcation) and phenomenological bifurcation (P-bifurcation) illustrated with some one-dimensional examples. Part three is some results on the stochastic Hopf bifurcation of quasi non-integrable Hamiltonian systems by using the largest Lyapunov exponent and by boundary classification. Part four is some results on the stochastic homoclinic bifurcation and random chaos of dissipated Hamiltonian systems under bounded noise or combined harmonic and Gaussian white noise excitation by using random Melnikov process with mean square criterion, the largest Lyapunov exponent and Poincare map.

[16]Project supported by the National Natural Scientific Foundation of China (No. 10371135)

Impact of dispersion on dynamics of a discrete metapopulation on two patches with local logistic dynamics

Xingfu Zou
Dept. of Applied Mathematics,
Memorial University of Newfoundland, Canada xzou@math.mun.ca

We propose and analyze a discrete time model for metapopulation on two patches with local logistic dynamics. The model carries a delay in the dispersion terms to account for long distance dispersion. Our results on this model shows that the impact of the dispersion on the global dynamics of the metapopulation is complicated and interesting: it can affect the existence of a positive equilibrium; it can either drive the metapopulation to global extinction, or prevent the metapopulation from global extinction and stabilize a positive equilibrium; it can also destabilize an otherwise stable positive equilibrium or a periodic orbit.