Workshop on Applied Analysis and Differential Equations

Department of Mathematics, University of Texas Pan-American, Edinburg, Texas 78539

Time: April 24, 2013 (Wednesday)
Location: Physical Science Building 1.102

Organizers:

Zhaosheng Feng
Zhijun Qiao
Karen Yagdjian

Department of Mathematics
University of Texas Pan-American
1201 W. University Drive
Edinburg, Texas 78539-2999
USA
Phone: (956) 665-7483
Fax: (956) 665-5091
E-mail: zsfeng@utpa.edu
qiao@utpa.edu
yagdjian@utpa.edu

Description:

This one-day workshop, sponsored by Department of Mathematics of the University of Texas Pan-American, is devoted to analysis and applications of differential equations.

This semester there are five visiting scholars: Yu Hou, Christian P. Jäh, Linping Peng, Yan Shen and Youhui Su, to join our department. This workshop is mainly aimed to present research works accomplished by these five scholars. In the workshop, a panorama of current research in differential equations and related dynamical systems will be presented, both at theoretical and computational level together with a clear view towards applications, in particular in biology and ecology etc.

Schedule of Talks

08:45-09:00	Welcome Remarks by Andras Balogh, Mathematics Department Chair	
Session Chair	Karen Yagdjian	
Time	**Speaker**	**Title**
09:00-09:45	Daniel N. Riahi (UTPA)	On modeling arterial blood flow systems
09:45-10:30	Christian P. Jäh (TU Bergakademie Freiberg, Germany)	Recent results on uniqueness in the Cauchy problem for degenerate elliptic PDE
10:30-11:15	Linping Peng (Beihang University, China)	The cyclicity of the period annulus of a quadratic reversible system with hemicycles
11:15-12:00	Yu Hou (Fudan University, China)	The quasi-periodic solutions for the modified Camassa-Holm hierarchy
12:00-13:30	**Lunch**	
Session Chair	Zhijun Qiao	
13:30-14:15	Yan Shen (Beijing Jiaotong University, China)	Super-resolution reconstruction of compressed sensing mammogram based on contourlet transform
14:15-15:00	Mrinal Kanti Roychowdhury (UTPA)	Quantization dimension and probability distribution
15:00-15:45	Youhui Su (Xuzhou Institute of Technology, China)	Homoclinic orbits and periodic solutions for a class of Hamiltonian systems on time scales
15:45-16:00	**Break**	
Session Chair	Zhaosheng Feng	
16:00-16:20	Marisabel Rodriguez (UTPA)	Evolution of within-host antibiotic resistance in Gonorrhea
16:20-16:40	Yufeng Cao (UTPA)	Synthetic aperture radar with compressive sensing
16:40-17:00	Xiaoqian Gong (UTPA)	First integral of Duffing-van der Pol oscillator system

ABSTRACTS OF TALKS

1. **Title:** Synthetic aperture radar with compressive sensing

Yufeng Cao
Department of Mathematics
University of Texas-Pan American
Edinburg, Texas 78539, USA
E-mail: ycao1@broncs.utpa.edu

Abstract: A general synthetic aperture radar (SAR) signal model is derived based on the Maxwell's equation, and three numerical simulations are analyzed and discussed. With this signal model, compressive sensing is applied to get a better image.

2. Title: The quasi-periodic solutions for the modified Camassa-Holm hierarchy

Yu Hou
Department of Mathematics
Fudan University
Shanghai, China
E-mail: houy@utpa.edu
10110180002@fudan.edu.cn

Abstract: The principal aim of this paper is to provide theta function representation of all quasi-periodic solutions and related quantities for the modified Camassa-Holm (MCH) hierarchy and study their algebro-geometric initial value problem. Our main tools include the polynomial recursion formalism, the hyperelliptic curve, the Baker-Akhiezer functions, and the associated trace formulas. With the help of these tools, the explicit theta function representations of the Baker-Ahhiezer functions, the meromorphic function and the quasi-periodic solutions for the entire MCH hierarchy are obtained.

3. Title: First integral of Duffing-van der Pol oscillator system

Xiaoqian Gong
Department of Mathematics
University of Texas-Pan American
Edinburg, Texas 78539, USA

E-mail: xgong@broncs.utpa.edu

Abstract: In this talk, we study a nonlinear Duffing—van der Pol--type oscillator system by means of the first-integral method. This system has physical relevance as a model in certain flow-induced structural vibration problems, which includes the van der Pol oscillator and the damped Duffing oscillator etc as particular cases. Firstly, we apply the Division Theorem for two variables in the complex domain, which is based on the ring theory of commutative algebra, to find a quasi-polynomial first integral to an equivalent autonomous system. Then through a certain parametric condition, we derive a general first integral of Duffing--van der Pol--type oscillator system.

4. Title: Recent results on uniqueness in the Cauchy problem for degenerate elliptic PDE

Christian P. Jäh
TU Bergakademie Freiberg
Institut für Angewandte Analysis, Germany
E-mail: christian.jaeh@math.tu-freiberg.de
g-cjah@utpa.edu

Abstract: We start the talk with an introduction into ill-posed problems and show why they are important for applications [1]. Furthermore we will give an easy introduction in the method of Carleman estimates and how they are used to prove uniqueness for certain PDE. After this we give a short review on existing results for degenerate elliptic operators and introduce results we have obtained during the last three months. We will consider the case of finite as well as infinite degeneration and our method to prove Carleman estimates, based on the approach in [2], can be used to handle both cases in a unified manner.

This talk is in cooperation with Dr. Karen Yagdjian, University of Texas - Pan American, USA

[1] D. Del Santo and Ch. P. Jäh, Non-uniqueness and uniqueness in the Cauchy problem of elliptic and backward-parabolic equations, pp 27--52, In: Progress in Partial Differential Equations--Asymptotic Profiles, Regularity and Well-Posedness (Eds: M. Reissig and M. Ruzhansky), Springer, London, 2013.
[2] A. Galstyan and K. Yagdjian, Uniqueness of the solution of the Cauchy problem for degenerate elliptic equations, Izv. Akad. Nauk Armyan. SSR Ser. Mat. 25(2) (1990), 203--208, 211; translation in Soviet J. Contemporary Math. Anal. 25(2) (1990), 85--91.

5. Title: The cyclicity of the period annulus of a quadratic reversible system with hemicycles

Linping Peng
School of Mathematics and System Sciences
Beihang University
Beijing 100191, China
E-mail: penglp@buaa.edu.cn
gping-l@utpa.edu

Abstract: In this talk, I will give an introduction about the cyclicity of the period annulus of a quadratic reversible and non-Hamiltonian system. Cyclicity here means the least upper bound of the number of isolated zeros of the Abelian integral related to the considered system under quadratic perturbations, which is also equal to the maximal number of limit cycles bifurcating from the period annulus surrounding the center of the considered system under quadratic perturbations. By studying the properties of some elliptic integrals and the geometries of the planar curves defined by them, we proved that the associated Abelian integral has at most two zeros, which implies that the cyclicity of the period annulus of the considered system under small quadratic perturbations is equal to two. This gives a positive answer to the conjecture given in [1].

[1] S.Gautier, L.Gavrilov L and I.D. Iliev, Perturbations of quadratic center of genus one, Discrete Contin. Dyn. Syst.25 (2) (2009), 511--535.

6. Title: On modeling arterial blood flow systems

Daniel N. Riahi
Department of Mathematics
University of Texas-Pan American
Edinburg, Texas78539, USA
E-mail: driahi@utpa.edu

Abstract: In this lecture we first review mathematical modeling and analyses that have been carried out recently for steady and unsteady single-phase blood flow in arteries with stenosis of different types. The types of fluid were either Newtonian with an Einstein type viscosity model or non-Newtonian. Next, we consider the relevant governing differential equations for the two-phase blood flow with heat transfer in an artery and in the presence of experimentally detected stenosis. We determine solutions for the dependent variables of the flow system and present the results for various quantities such as the flow velocity and temperature, pressure drop, shear stress and

the heat flux on the boundary of the artery. We explain the main mechanisms that can be operative in such artery flow system and discuss our results that can be useful for understanding ways to improve the patience's health.

7. Title: Evolution of within-host antibiotic resistance in Gonorrhea

Marisabel Rodriguez
Department of Mathematics
University of Texas-Pan American
Edinburg, Texas 78539, USA
E-mail: mrodriguezy5@broncs.utpa.edu

Abstract: In the past decades, Gonorrhea, a sexually transmitted bacterial infection caused by Neisseria gonorrhoeae, has become resistant to a wider range of antibiotics. In this paper, we consider the competition dynamics of multiple N. gonorrhoeae bacterial strains within a host in an effort to better understand the development of antibiotic resistance and examine individual-patient treatment regimes to determine conditions for within-host antibiotic-resistance emergence. To that aim, we propose a phenomenological model that takes into account essential ideas such as the effects of different treatment levels, the mutation rates of bacteria, and the response of the immune system. Numerical simulations also provide a more integral view of how model parameters affect the emergence of within-host resistance.

8. Title: Quantization dimension and probability distribution

Mrinal Kanti Roychowdhury
Department of Mathematics
University of Texas-Pan American
Edinburg, Texas78539, USA
E-mail: roychowdhurymk@utpa.edu

Abstract: 'Quantization' refers to the process of approximating the continuous set of values in the image data with a finite (preferably small) set of values. It is a process of approximation, and a good quantizer is one which represents the original signal with minimum loss of distortion. 'Quantization dimension' gives the speed how fast some specified measure of the error (also called the distortion or noise, between the quantized distribution and the original distribution) goes to zero as n goes to infinity.

9. Title: Super-resolution reconstruction of compressed sensing mammogram based on contourlet transform

Yan Shen
School of Electronic and Information Engineering
Beijing Jiaotong Univeristy
Beijing 100044, China
E-mail: sheny@bjtu.edu.cn
vscholar-sheny@utpa.edu

Abstract: Calcification detection in mammogram is important in breast cancer diagnosis. A super-resolution reconstruction method is proposed to reconstruct mammogram image from one single low resolution mammogram based on the compressed sensing by the contourlet transform. The initial estimation of the super-resolution mammogram is obtained by the interpolation method of the low resolution mammogram reconstructed by compressed sensing. Then the contourlet transform is applied respectively to the initial estimation and the reconstructed low resolution mammogram. From the statistical characteristics of the mutiscale frequency bands between the initial estimation and the reconstructed low resolution mammogram, the thresholds are estimated to integrate the high frequency of the initial estimation and the low frequency of the reconstructed low resolution mammogram. The super-resolution mammogram is achieved through the reconstruction of contourlet inverse transform. The proposed method can retrieve some details of the low resolution images. The calcification in mammogram can be detected efficiently.

10. Title: Homoclinic orbits and periodic solutions for a class of Hamiltonian systems on time scales

Youhui Su
Department of Mathematics
Xuzhou Institute of Technology
Xuzhou 221116, China
E-mail: yhsu@xzit.edu.cn
suyh02@163.com

Abstract: In this talk, we are concerned with a second order non-autonomous Hamiltonian system on time scales T. Under certain conditions, the existence and multiplicity of periodic solutions are obtained for this Hamiltonian system on time scales by using the saddle point theory, the least action principle as well as the three-critical-point theorem. In addition, the existence of homoclinic orbit is obtained as a limit of 2kT-periodic solutions of a given sequence of Hamiltonian system on time

scales by means of the mountain pass theorem and the standard minimizing argument. The obtained results generalize some existing results in the literature [1, 2].

[1] Y.H. Su and Z. Feng, A non-autonomous hamiltonian system on time scales, Nonlinear Anal. (TMA), 75 (2012), 4126--4136.
[2] J. Zhou and Y. Li, Sobolev's spaces on time scales and its applications to a class of second order Hamiltonian systems on time scales, Nonlinear Anal. (TMA), 73 (2010), 1375--1388.