2015 Fall Visiting Scholars Workshop on Differential Equations and Dynamical Systems with Applications in Physics and Biology

School of Mathematical and Statistical Sciences
The University of Texas-Rio Grande Valley

Time: Saturday, November 14, 2015
Location: MAGC 2.208, Edinburg Campus of UT-RGV

Organizers:

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Description

The School of Mathematical and Statistical Sciences at the University of Texas-Rio Grande Valley is hosting a single day workshop devoted to differential equations and dynamical systems, with applications in physics and biology. We have the pleasure of hosting eleven visiting scholars this academic year who will participate in the workshop.

The purpose for this workshop is two-fold: (1) to encourage faculty, students, and visiting scholars to present their recent research results; and (2) to promote communication and collaboration between faculty, students, and the visiting scholars. The workshop will feature a panorama of current research in the theory and computation of differential equations and dynamical systems, with a clear view towards applications in physics and biology.

For further information, please contact Zhaosheng Feng at zhaosheng.feng@utrgv.edu.

Schedule of Talks

08:45-09:00	Opening Speech: Dr. Cristina Villalobos (Director of SMSS) and Dr. Parwinder Grewal (Dean of College of Science)	
Session Chair	Dr. Zhijun Qiao	
Time	**Speaker**	**Title**
09:00-09:30	Dr. Ranadhir Roy (UTRGV)	Blood Flow in Heterogeneous Brain Tumor: Concurrent Application of Chemotherapy and Radiotherapy
09:30-10:00	Dr. Hengchun Hu (University of Shanghai for Science and Technology, China)	CTE method and new interaction solutions for the coupled integrable dispersionless equation
Session Chair	Dr. Vesselin Vatchev	
10:00-10:30	Dr. Tamer Oraby (UTRGV)	Bounded rationality influences the rates of vaccine acceptance and dynamics of infectious diseases
10:30-11:00	Dr. Qiaoyi Hu (South China Agricultural University, China)	Analyticity, Gevrey regularity and unique continuation for an integrable multi-component peakon system with an arbitrary polynomial function
Session Chair	Dr. Ranadhir Roy	
11:00-11:30	Dr. John Villavert (UTRGV)	Global regularity and well-posedness for the incompressible Navier-Stokes equations and the Keller-Segel model in R^n
11:30-12:00	Dr. Juntao Sun (Shandong University of Technology)	Ground state solution for a class of non-autonomous Schrodinger-Poisson systems in dimension three
12:00-13:30	**Lunch**	
Session Chair	Dr. Baofeng Feng	
13:30-14:00	Dr. Josef Sifuentes (UTRGV)	Approximate deflation preconditioning for iterative methods
14:00-14:30	Dr. Hongxia Wu (Jimei University, China)	A new generalization of dispersionless BKP hierarchy

14:30-15:00	Dr. Qiangjun Xie (Hangzhou Dianzi University, China)	Optimal harvesting of a diffusive population model with size random growth and distributed recruitment
15:00-15:10	**Break**	
Session Chair	Dr. Josef Sifuentes	
15:10-15:40	Dr. Erwin Suazo (UTRGV)	Closed solutions for inhomogeneous linear and nonlinear Schrodinger equations
15:40-16:10	Dr. Long Li (Hengyang Normal University, China)	A smoothing algorithm with constant learning rate for training fuzzy neural networks and its convergence
16:10-16:40	Ms. Bianxia Yang (Lanzhou University, China)	Unilateral global bifurcation, half-linear eigenvalues and constant sign solutions for a fractional Laplace problem

ABSTRACTS OF TALKS

1. **Title:** Blood flow in heterogeneous brain tumor: concurrent application of chemotherapy and radiotherapy

Ranadhir Roy
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Abstract: Heterogeneous brain tumors are highly invasive and therefore extremely difficult to treat. A combination of surgery, radiation therapy and chemotherapy are the routine treatment for brain tumors. Many studies have demonstrated a better outcome with concurrent application of radiotherapy and chemotherapy. Thus combined radiotherapy and chemotherapy treatment can improve the survival rate. Our major objective in this work is to understand the physiology of blood flow, and also to investigate the effect of concurrent application of two anti-cancer drugs in a brain tumor. Drug transport in the tumor interstitial depends on convection and diffusion. To investigate characteristics of blood flow through a spherical tumor, a couple convection-diffusion-reaction models for simulating interaction between two anti- cancer drugs has been developed. The interstitial fluid pressure, velocity and drugs distribution

are calculated using finite element methods. The finite element solution of this problem is presented and demonstrated that concurrent application of chemotherapy and radiotherapy will improve the survival rate.

2. **Title:** CTE method and new interaction solutions for the coupled integrable dispersionless equation

Hengchun Hu
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Abstract: The consistent tanh expansion (CTE) method is developed for the coupled integrable dispersionless equation (CID). The CID equation is proved to be CTE solvable. New exact interaction excitations such as soliton-cnoidal wave solutions, soliton-periodic wave solutions and multiple resonant soliton solutions are given out analytically and graphically.

3. **Title:** Bounded rationality influences the rates of vaccine acceptance and dynamics of infectious diseases

Tamer Oraby
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Abstract: Many social and cognitive factors can influence the parents' decision to accept vaccinating their children against paediatric diseases. In this talk, I will present a recently published model [1] that investigates the influence of bounded rationality on the rates of vaccine acceptance. In that work, my coauthor and I have found that social norms can always correct for the bounded rationality in vaccination decision-making. Stability analysis and simulations of the model will be presented.

[1] T. Oraby and C.T. Bauch, Bounded rationality alters the dynamics of paediatric immunization acceptance. *Scientific Reports*, 5: 10724, (2015).

4. **Title:** Analyticity, Gevrey regularity and unique continuation for an integrable multi-component peakon system with an arbitrary polynomial function

Qiaoyi Hu
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Abstract: In this paper, we study the Cauchy problem for an integrable multicomponent (2N-component) peakon system which is involved in an arbitrary polynomial function. Based on a generalized Ovsyannikov type theorem, we first prove the existence and uniqueness of solutions for the system in the Gevrey-Sobolev spaces with the lower bound of the lifespan. Then we show the continuity of the data-to-solution map for the system. Furthermore, by introducing a family of continuous diffeomorphisms of a line and utilizing the fine structure of the system, we demonstrate the system exhibits unique continuation.

5. **Title:** Global regularity and well-posedness for the incompressible Navier-Stokes equations and the Keller-Segel model in R^n

John Villavert
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Abstract: In this talk, we will discuss the global regularity and well-posedness for the Cauchy problem to the 3D incompressible Navier-Stokes equations and the 2D Keller-Segel model in critical function spaces, e.g., the Lebesgue spaces, Besov spaces and TriebelLizorkin spaces. If time permits, we will discuss an optimal result on the ill-posedness of the Keller-Segel model in Lebesgue and Triebel-Lizorkin spaces. Namely, we describe the conditions in which the solution may exhibit norm inflation, i.e., the solution becomes arbitrarily large after an arbitrarily short time even for small initial data.

6. **Title:** Ground state solution for a class of non-autonomous Schrodinger-Poisson systems in dimension three

Juntao Sun
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Abstract: Schrodinger-Poisson system, also known as the nonlinear Schrodinger-Maxwell equations, is suggested as a model describing the interaction of a charged particle with the electrostatic field in quantum mechanics. In this talk, by introducing a new set, which is the filtration of the Nehari manifold together with variational methods, we are concerned with the existence of ground state solution for a class of non-autonomous Schrodinger-Poisson systems without any symmetry assumptions.

7. **Title:** Approximate deflation preconditioning for iterative methods

Josef Sifuentes
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Abstract: Many numerical methods for differential equations and dynamical systems require Krylov-subspace based iterative methods for solving linear systems. Often, one wants to recycle basis vectors of the Krylov subspace to either restart an iterative method, or to gain an advantage when solving the same linear system with different right hand sides, for example when applying implicit time stepping to differential systems. This talk will address different deflation strategies and analyze the difference between exact and approximate spectral deflation and it's relationship to the stability of the GMRES iterative method, which is based on the Krylov subspace.

8. **Title:** A new generalization of dispersionless BKP hierarchy

Hongxia Wu
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Abstract: The symmetry constraint for dispersionless BKP (dBKP) hierarchy is firstly derived by taking dispersionless limit of that for BKP hierarchy. Then, based on the symmetry constraint for dBKP hierarchy, a new extended dBKP hierarchy is constructed. In addition, the integrability of this new extended dBKP hierarchy is proved by presenting its zero-curvature equation and the related conservation equation. From its zero-curvature equation, two types of dBKP equations with self-consistent sources (dBKPESCS) together

with their associated conservation equations are obtained. Hodograph solutions for the first type of dBKPESCS are finally obtained.

9. **Title:** Optimal harvesting of a diffusive population model with size random growth and distributed recruitment

Qiangjun Xie
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Abstract: In this talk, we consider an optimal harvesting control problem for a spatial diffusion population system, which incorporates individual's random growth of size and distributed style of recruitment. The existence and uniqueness of nonnegative solutions to this practical model is studied by means of Banach's fixed point theorem, and the continuous dependence of population density on the harvesting effort is analyzed. The optimal harvesting strategies are established by the normal cone and adjoint techniques.

10. **Title:** Closed solutions for inhomogeneous linear and nonlinear Schrodinger equations

Erwin Suazo
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Abstract: Using Ermakov and Riccati type systems, we present how we can construct explicit solutions for the propagator for a generalized harmonic oscillator. This has applications describing the process of degenerate parametric amplification in quantum optics. We also present explicit solutions of the inhomogeneous paraxial wave equation in a linear and quadratic approximation, showing the existence of oscillating laser beams in a parabolic waveguide and spiral light beams in varying media. Finally, using a similar approach we show how we can construct soliton solutions for the nonautonomous nonlinear Schroedinger equation.

11. **Title:** A smoothing algorithm with constant learning rate for training fuzzy neural networks and its convergence

Long Li
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Abstract: In this talk, a smoothing algorithm with constant learning rate is presented for training fuzzy neural networks (FNNs), covering two classes of FNNs: *max-product* and *max-min* fuzzy neural networks. Some weak and strong convergence results for this algorithm are proved, indicating that the error function monotonically decreases, the gradient of it goes to zero and weight sequence goes to a fixed value in the iteration, respectively. Some conditions for the constant learning rate to guarantee the convergence are specified. Finally, two numerical examples are provided to illustrate the feasibility and efficiency of this algorithm and support the theoretical findings.

12. **Title:** Unilateral global bifurcation, half-linear eigenvalues and constant sign solutions for a fractional Laplace problem

Bianxia Yang
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Abstract: In this talk, we are concerned with the unilateral global bifurcation structure of fractional differential equation with non-differentiable nonlinearity. As an application of the unilateral global bifurcation results, we derive the existence of the principal half-eigenvalues of half-linear fractional eigenvalue problem. Furthermore, we investigate the existence of constant sign solutions for a class of fractional nonlinear problem. The main results can be seen as extend the known results about classical Laplace operator to the fractional Laplace type operator.