2019 Workshop on Nonlinear Partial Differential Equations (PDEs) with Interdisciplinary Applications

Time： 8:30 AM to 5:30 PM, Saturday, November 16, 2019
Location: EMAGC 2.416, Edinburg Campus of the University of Texas Rio Grande Valley

Organizers:

Dambaru Bhatta	dambaru.bhatta@utrgv.edu
Eleftherios Gkioulekas	drlf@hushmail.com
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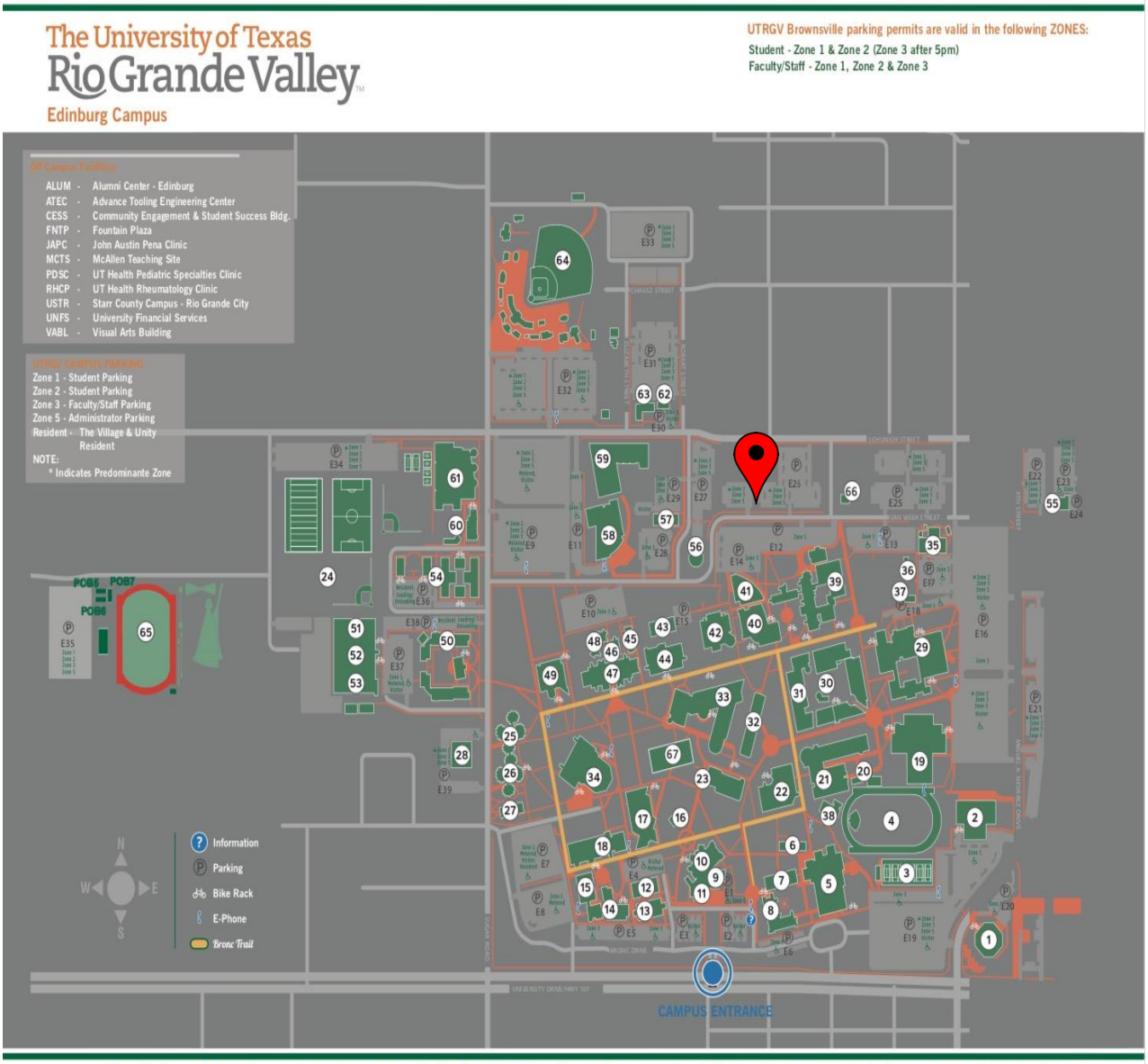
Welcome

The School of Mathematical and Statistical Sciences is pleased to announce the 2019 Workshop on Nonlinear Partial Differential Equations (PDEs) with Interdisciplinary Applications. The workshop provides a leading forum for disseminating the latest research in the areas of nonlinear PDEs, including qualitative analysis, integrable systems, negative flows, peakons, symmetries and geometry, and nonlinear soliton models, and brings together students, faculty, and visiting scholars from the nonlinear science community to initiate new collaborations and co-operations in their common research fields.

Description

The School of Mathematical and Statistical Sciences at the University of Texas-Rio Grande Valley is hosting a single day workshop devoted to Nonlinear Partial Differential Equations (PDEs) with Interdisciplinary Applications. The purpose for this workshop is two-fold: (1) encouraging faculty, students, and visiting scholars to present their recent research results; and (2) promoting communication and collaboration among faculty, students, and the visiting scholars. The workshop will feature a panorama of current research in the theory and computation of Nonlinear Partial Differential Equations (PDEs) with a clear view towards the interdisciplinary applications. Thanks to the School of Mathematical and Statistical Sciences and the Endowed Professorship Program for supporting the workshop.

Map of UTRGV and address of the workshop



Schedule of Presentations

8:45-09:00	Opening Dr. Vivian Incera (COS Dean) Dr. Huber (SMSS Director)	
Chair	Dr. Zhijun Qiao	
Time	**Speaker**	**Title**
09:00-09:40	Dr. Stephen Anco	New integrable peakon equations from a modified AKNS scheme
09:40-10:20	Dr. Baofeng Feng	A unified tau-function structure for the Degasperis-Procesi equation and the Novikov equation
10:20-10:30	**Break**	
Chair	Dr. Dambaru Bhatta	
10:30-11:10	Dr. Karen Yagdjian	Hyperbolic equations in the curved space-time of FLRW models of Cosmology
11:10-11:50	Dr. S. M. Mallikarjunaiah	An Iterative Staggered Finite Element Scheme for Quasi-Static Crack Propagation in Non-Linear Elastic Solids
11:50-13:30	**Lunch (On Site)**	
Chair	Dr. Vesselin Vatchev	
13:30-14:10	Dr. D.E. Pelinovsky	Rogue waves on the periodic and double-periodic background
14:10-14:50	Dr. Eleftherios Gkioulekas	Revisiting the dissipation scales of the energy cascade of 3D turbulence as anomalous scaling functions
14:50-15:30	Dr. Zhijie Cao	The symmetries and conservation laws of a time dependent nonlinear reaction-convection-diffusion equation

15:30-15:40	**Break**	
Chair	Dr. Eleftherios Gkioulekas	
15:40-16:20	Dr. Dambaru Bhatta and Dr. Daniel N Riahi	Effects of thermal diffusivity and hydraulic resistivity on a hydro-thermal convective flow in porous media
16:20-17:00	Dr. Xiaodong Fan	Attribute reduction for multi-label classification based on label positive region

ABSTRACTS

1. Title: New integrable peakon equations from a modified AKNS scheme

Dr. Stephen Anco
Department of Mathematics & Statistics
Brock University, Canada

Abstract: Peakon equations are nonlinear dispersive wave equations that possess peaked travelling wave solutions (known as "peakons") analogous to solitons. Recently, a large class of peakon equations with multi-peakon solutions has been identified and studied. It contrasts to solitons, however, no integrability properties are required for existence of multi-peakons, and only a few examples of integrable peakon equations are known.
In this talk I will present some new integrable peakon equations and discuss some of their properties. These new equations have been found through a modified version of the standard AKNS scheme for generating integrable evolution equations, based on sl(n,R) matrices. In the simplest case of 2x2 matrices, the modified scheme yields a universal 3-component peakon system whose 1-component reductions include the well-known Camassa-Holm equation, the modified Camassa-Holm (FORQ) equation, as well as a new parity non-invariant equation. Other reductions yield 2-component generalizations of these equation, and Qiao's equation involving arbitrary functions. Progress on the next simplest case of 3x3 matrices will be reported.

2. Title: Effects of thermal diffusivity and hydraulic resistivity on a hydro-thermal convective flow in porous media

Dr. Dambaru Bhatta and Dr. Daniel N Riahi
School of Mathematical & Statistical Sciences
UTRGV, Edinburg, TX

Abstract: We consider a hydro-thermal convective flow in a horizontal porous medium. This flow system is governed by a set of partial differential equations containing the continuity equation

for conservation of mass, Darcy law for conservation of momentum and heat equation for conservation of energy. Assuming a no-flow basic state system and applying weakly nonlinear approach, we investigate the effects of vertical variation in thermal diffusivity and hydraulic resistivity on velocity and temperature. The results obtained indicate a stabilizing effect on the flow and temperature for a positive vertical rate of change in both diffusivity and resistivity, whereas a destabilizing effect occurs for a negative vertical rate of change.

3. Title: The symmetries and conservation laws of a time dependent nonlinear reaction-convection-diffusion equation

Dr. Zhijie Cao
Visiting Scholar
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Abstract: In this talk, we study a nonlinear diffusion-convection-reaction equation with a variable coefficient which has applications in the survey of some important phenomena in physics, chemistry, and biology. The Lie point symmetries of this equation are derived, according to which this equation is classified into four different kinds. Conservation laws for this equation are constructed by using the conservation theorem of Ibragimov for the first time.

4.Title: A unified tau-function structure for the Degasperis-Procesi equation and the Novikov equation

Dr. Baofeng Feng
Professor of Mathematics
School of Mathematical and Statistical Sciences
University of Texas Rio Grande Valley

Abstract: It is known that, through hodograph (reciprocal) transformation, the Degasperis-Procesi (DP) equation is linked to the negative flow of the Kaup-Kuperschmidt (KK) hierarchy while the Novikov equation is connected to the negative flow of the Sawada-Kotera (SK) hierarchy. The solutions of the KK and SK equations are linked to the solution of the modified KK equation through the Miura map. In this talk, we will show how to derive the DP equation and the Novikov equation from the pseudo-3 reductions of the CKP and BKP hierarchies, respectively, and reveal a unified tau-function structure behind the DP and Novikov equations with a pfaffian lattice as the building blocks.

5. Title: Attribute reduction for multi-label classification based on label positive region

Dr. Xiaodong Fan

Visiting Scholar
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Abstract: Four attribute reduction algorithms for multi-label data, which are the multi-label versions of positive region reduction, are proposed on the basis of rough set theory. According to the label sets from the equivalent or similar class of a sample, the proposed algorithms utilize the label ratio to determine the label set for the unseen sample. The relationship between the proposed methods and two classical attribute reductions are analyzed, which shows that the proposed methods are more applicable to multi-label classification. Experiment results illustrate that the proposed algorithms can remove redundant attributes without reducing classification accuracy for most data.

6. Title: Revisiting the dissipation scales of the energy cascade of 3D turbulence as anomalous scaling functions

Dr. Eleftherios Gkioulekas
Undergraduate Program Coordinator
School of Mathematical and Statistical Sciences
University of Texas Rio Grande Valley
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Abstract: The usual concept of an energy cascade that has a unique associated dissipation scale is an oversimplification. Aside from the fact that self-similar scaling for higher-order structure functions terminates at different dissipation scales, back in 1996, L'vov and Procaccia noted an additional anomaly; starting from an nth order generalized structure function, consisting of a product of velocity differences, each between two different points, when all velocity difference separations have length scale R and one velocity difference separation is reduced to a smaller scale r, the crossover to dissipation range will occur at the scale $\ell_n(R)$ which is *R* - dependent. The fixed point λ_n such that $\ell_n (\lambda_n)=\lambda_n$ gives the standard dissipation scale associated with the n^{th}-order standard structure functions. In my talk, I will make note of an additional anomaly. If, instead of reducing one velocity difference separation, we reduce *p* velocity difference separations to scale r, that defines a different dissipation scale function $\ell_{np}(R)$ and a different fixed-point λ_{np}. The new anomaly is that λ_{np} is not independent of *p*.

7.Title: An Iterative Staggered Finite Element Scheme for Quasi-Static Crack Propagation in Non-Linear Elastic Solids

Dr. S. M. Mallikarjunaiah

Department of Mathematics & Statistics
Texas A&M University - Corpus Christi

Abstract: The subject of this talk is quasi-static fracture propagation in non- linear elastic solids using regularized phase-field approach. A main purpose of the talk is to describe an efficient iterative bi-linear finite element discretization of the model that involves energy minimization under constraint. The class of constitutive relationship considered, in this work, to model the response of elastic solids, give rise to a nonlinear relationship between classical linearized strain and Cauchy stress. Such a formulation not only known to exhibit much richer behavior than classical model, but also predict finite crack-tip strains. The non-linear two-field displacement phase-field system is solved via a staggered coupling and a penalization technique is adopted to enforce the crack-irreversibility. Several numerical tests will be presented to show the robustness of the algorithm.

8. Title: Rogue waves on the periodic and double-periodic background

Dr. D. E. Pelinovsky
McMaster University Department of Mathematics and Statistics, 1280 Main Street West, Hamilton, L8S 4K1, Ontario, Canada Dmitry Pelinovsky
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Abstract: We address Lax-Novikov equations derived from the cubic NLS equation. Lax-Novikov equations of the lowest orders admit explicit periodic and double-periodic solutions expressed as rational functions of Jacobian elliptic functions. By applying an algebraic method which relates the periodic potentials and the squared periodic eigenfunctions of the Lax operators, we characterize explicitly the location of eigenvalues in the periodic spectral problem away from the imaginary axis. We show that Darboux transformations with the periodic eigenfunctions remain in the class of the same periodic waves of the NLS equation. On the other hand, Darboux transformations with the non-periodic solutions to the Lax equations produce rogue waves on the periodic background which are formed in a finite region of the time-space plane.

9. **Title:** Hyperbolic equations in the curved space-time of FLRW models of Cosmology

Dr. Karen Yagdjian
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Abstract: In this talk we describe some quantitative and qualitative properties of the solutions of linear and nonlinear hyperbolic equations in the curved space-times. These properties are obtained by representation formulas written via the integral transform approach that was developed by the author. Special attention is given to the solutions of the equations in the FLRW space-time.