Abstracts: Conference on Integrable Systems, Random Matrix Theory and Combinatorics
October 23 – 26, 2013

Wednesday, October 23

8:30am – 9:20am

Analisa Calini
calinia@cofc.edu
College of Charleston

Curve Flows and Soliton Equations: the case of the vortex filament.

The Vortex Filament Equation, describing the self-induced motion of a vortex filament in an ideal fluid, is a simple but important example of integrable curve dynamics. Its connection with the nonlinear Schroedinger equation through the well-known Hasimoto map allows the use of many of the tools of soliton theory to study properties of its solutions. In this talk I will discuss the construction of knotted solutions, their dynamics, and their stability properties.

9:30am – 10:20am

Leonard Choup
leonard.choup@uah.edu
University of Alabama at Huntsville

Gaussian orthogonal Ensemble revisited

11:00am – 11:50am

Igor Rumanov
Igor.Rumanov@colorado.edu
University of Colorado

Classical integrability for beta-ensembles and general Fokker-Planck equations.

Beta-ensembles of random matrices are naturally considered as quantum integrable systems, e.g. due to their relation with conformal field theory, and more recently appeared connection with quantized Painlevé Hamiltonians. We demonstrate that (at least for even integer beta) there are Lax pairs associated with them, which we show how to construct. More generally, we show that a solution of every Fokker-Planck equation in one space (and one time) dimensions can be considered as a component of an eigenvector of a Lax pair. The explicit finding of the Lax pair depends on finding a solution of a governing system – a closed system of two nonlinear PDEs of hydrodynamic type. We find the solution of this system for even integer beta in the case of quantum Painlevé II related to the soft edge of the spectrum for beta-ensembles. The solution is given in terms of Calogero system of $\beta/2$ particles in an additional time-dependent potential.

2:00pm – 2:25pm

Robert Jenkins
robert.jenkins@sissa.it
Scuola Internazionale Superiore di Studi Avanzati

2:30pm – 2:55pm
Anton Dzhamay
Anton.Dzhamay@unco.edu
University of Northern Colorado

Hamiltonian Description of Schlesinger Transformations and the Geometry of Discrete Painlev Equations

In this talk I will first show that, similar to the continuous case of Schlesinger equations, discrete Schlesinger transformations also can be written in a Hamiltonian form. Second, I will explain how the geometric description of a discrete Painlev equation can help us in comparing equations of the same symmetry type, but obtained in different ways.

Thursday, October 24

8:30am – 9:20am
Seung-Yeop Lee
lees3@usf.edu
University of South Florida

Topology of 2D equilibrium measure

We study the class of external potentials whose derivative is given by a rational function. Given a degree of the rational function, there exists a bound in the maximal number of components in the support of equilibrium measure (that we call "droplet"). In this talk, we show that this bound is sharp, meaning that there exists a rational function that realizes the maximal number of components in a droplet. The proof involves classical results (1972) regarding univalent polynomials on a disk by Suffridge. The work is a joint work with Nikolai Makarov.

9:30am – 10:20am
Alfredo Deaño
alfredo.deanho@uc3m.es
Universidad Carlos III de Madrid
alfredo.deano@cs.kuleuven.be
KU Leuven

Partition function in the Hermitian random matrix model with cubic potential

We present results on the large N expansion of the free energy and the partition function of a unitary random matrix model with weight $w(z) = e^{-NV(z)}$, where the potential is a perturbation of GUE of the form $V(z) = z^2/2 - uz^3$, and $u > 0$ is a real parameter. For small enough u, the free energy $F_N(u)$ can be expanded in powers of N^{-2}, in the so called topological expansion which goes back to the work of Brzin, Itzykson, Parisi and Zuber. Close to an explicit critical value $u = u_c$, it is necessary to consider a double scaling limit, and the asymptotic behavior of the free energy has a non-trivial correction with respect to the regular case, given in terms of a certain family of solutions of the Painlev I differential equation.

11:00am – 11:50am

Adrían Espínola-Rocha
`jaer.cimat.mx@gmail.com`
Universidad Autónoma Metropolitana - Azcapotzalco

Riemann Surfaces associated to the Nonlinear Schrödinger equation: A Kamchatnov-Kraenkel-Umarov spectral problem approach

Mathematics Colloquium

4:00pm – 5:00pm

Maciej Zworski
University of California, Berkley

Friday, October 25

8:30am – 9:20am

Constance Schober
`cschober@mail.ucf.edu`
University of Central Florida

9:30am – 10:20am

Robert Buckingham
`robert.buckingham@uc.edu`
University of Cincinnati

11:00am – 11:50am

Pavel Bleher
`bleher@math.iupui.edu`
Indiana University-Purdue University Indianapolis

Applied Mathematics Colloquium

Peter Miller
4:00pm – 5:00pm millerpd@umich.edu
University of Michigain

Weakly Dispersive Internal Waves

Asymptotic models for internal wave motion in 1+1 dimensions include nonlocal linear dispersion terms arising from the elimination of potential flow on one side of the interface via a Dirichlet-Neumann map. Such models include the intermediate long wave equation in the case of finite depth and the Benjamin-Ono equation in the case of infinite depth (of the lower fluid layer). In some situations it is physically reasonable to assume that the dispersive effects are formally small compared with nonlinear effects that eventually lead to wave breaking, and then it is interesting to study the effect that weak dispersion has as a regularizing effect on the breaking waves. This problem has been studied for many years in the context of the Korteweg-de Vries equation, with key ideas going back to Whitham, Gurevich-Pitaevskii, and Lax-Levermore, and with more modern developments such as the results of Claeys and Grava arising from the Deift-Zhou steepest descent method for Riemann-Hilbert problems. In this talk, I will describe some of our attempts to study the corresponding problem in the context of the Benjamin-Ono equation. In particular, we will present a simple and intuitive weak convergence result (joint work with Z. Xu) that is a consequence of a new analogue of the variational method of Lax and Levermore but that takes as inspiration also the moment expansion method of Wigner in random matrix theory.

Saturday, October 26

Barbara Shipman
8:30am – 9:20am bshipman@uta.edu
University of Texas at Arlington

Lorentz-Conformal Transformations in the Plane

While conformal transformations of the plane preserve Laplaces equation, Lorentz-conformal mappings preserve the wave equation. We characterize classes of Lorentz-conformal mappings by their symmetries under subgroups of the dihedral group of order eight. Unfoldings of non-invertible mappings into invertible ones are reflected in a change of the symmetry group, and in different colorings of the contour plot. We discover how certain simple geometric objects are transformed under nonlinear Lorentz-conformal mappings. Squares are transformed into curvilinear quadrilaterals where three sides determine the fourth by a geometric rectangle rule, which can be expressed also by functional formulas. Another rectangle rule governs pairs of crossing curves that can be mapped to intersecting coordinate lines. The questions are simple; but the answers are not obvious, yet have beautiful geometric, algebraic, and functional descriptions and proofs. This is due to the very simple form of nonlinear Lorentz-conformal transformations in dimension 1+1, provided by characteristic coordinates. This is joint work with Patrick Shipman and Stephen Shipman.

9:30am – 10:20am **Thomas Bothner**
tbothner@umail.iu.edu
Centre de Recherches Mathématiques

Transition asymptotics for the sine-kernel determinant

This talk discusses the double scale asymptotics of the Fredholm determinant $\det(I-\gamma K_{\sin})$ as $\gamma \to 1^-$, $s \to \infty$ where $K_{\sin}$ is a trace class operator on $L^2\big((-s,s);d\lambda\big)$ whose kernel is the famous sine-kernel. This one parameter family of determinants appears in random matrix theory (description of certain spectral properties of large Hermitian matrices), in analytic number theory (Montgomery-Odlyzko conjecture concerning the zeros of the Riemann zeta-function), in the theory of the one-dimensional impenetrable Bose gas (emptiness formation probability and other correlation functions), as well as in a number of other important mathematical and theoretical physics applications.

In order to derive the desired asymptotics, we use the given integrable form of the Fredholm operator which allows us to connect the resolvent kernel to the solution of a Riemann-Hilbert problem, a problem which can be analysed rigorously in the framework of the Deift-Zhou nonlinear steepest descent method. We highlight various technical features in the implementation of the method related to different choices of the double scaling parameter $\kappa = -\frac{\ln(1-\gamma)}{2s}$. This is joint work with Percy Deift, Alexander Its and Igor Krasovsky.

11:00am – 11:25am **David Smith**
smith5dd@ucmail.uc.edu
University of Cincinnati

Wellposedness and spectral representation of linear initial-boundary value problems

We study initial-boundary value problems for linear constant-coefficient evolution equations on a finite 1-space, 1-time domain. Classical separation of variables and Fourier transform methods fail for all problems except those of second order or those with very special boundary conditions whereas the method of Fokas and Pelloni solves any such well-posed problem. We describe the well-posedness criteria obtained by Pelloni and Smith and provide a functional-analytic view of the failure of classical methods and success of Fokas method.

11:30am – 11:55am **Virgil Pierce**
piercevu@utpa.edu
University of Texas – Pan American

Generating Functions for Dispersionless Limits of Integrable Systems and Map Enumeration.

We are considering generating functions giving dispersionless limits of the Toda lattice and Pfaff lattice integrable hierarchies. They give a consolidated description of hierarchies of partial differential equations which determine the log-partition function of the GUE and GOE ensembles of random matrices. We will show that a symmetry result known in earlier work is readily apparent in this setting, and discuss using this approach to extend existing results to the case of the Pfaff lattice hierarchy and the GOE ensemble of random matrices. This gives a method for extending the enumeration of oriented maps to unoriented maps.