Flows on the Saskatchewan: A Workshop on Integrability and Inverse Problems

April 6-7, 2019
University of Saskatchewan

Saturday, April 6th (PHYSICS 130)

9:30 am: Alex Himonas (Notre Dame)

- **Title**: On the analysis of integrable evolution equations
- **Abstract**: In this talk we shall consider questions of existence, uniqueness, dependence on initial data, and regularity of solutions to the Cauchy problem of Camassa-Holm and related integrable equations in a variety of function spaces. Some of these equations can be thought as "toy" models for the Euler equations governing the motion of an incompressible fluid, and the analytic techniques developed for these equations have been in some cases transferable to the Euler equations. In particular, we shall discuss the

phenomena of norm-inflation and non-uniquness that arise when attempting to prove well-posedness for these equations with low regularity data. Peakon traveling wave solutions are the basic ingredients. The talk is based on work in collaboration with C. Kenig, C. Holliman, D. Mantzavinos, G. Misiolek and G. Petronilho.

11:00 am: Feride Tiglay (Ohio)

- **Title**: Integrating the μHS equation
- **Abstract**: The μHS equation is a Euler-Arnold equation corresponding to a natural right-invariant Sobolev metric. It is bihamiltonian and admits a Lax pair. We describe how to use Fredholm determinants to construct special functions and integrate this equation.

2:00 pm: Richard Beals (Yale)

- **Title**: Jacek, C. S. Meijer, and me
- **Abstract**: This talk will discuss randomness, serendipity, an enjoyable collaboration, and our most popular paper.

4:30 pm: Niky Kamran (McGill)

- **Title**: A survey of non-uniqueness results for the anisotropic Calderon problem with disjoint data
- **Abstract**: The anisotropic Calderon problem is an inverse problem of geometric analysis which consists in recovering, up to some natural gauge equivalences, the metric of a compact Riemannian manifold with boundary from the knowledge of the Dirichlet-to-Neumann map a fixed energy. We shall give a motivated review of some recent non-uniqueness results obtained for the anisotropic Calderon problem in the case in which the Dirichlet and Neumann data are measured on disjoint subsets of the boundary. These examples consist in Riemannian manifolds diffeomorphic to toric cylinders endowed with suitably chosen conformal rescalings of warped product metrics, where the conformal factors are governed by non-linear second-order elliptic pdes of Yamabe type. These are joint results with Thierry Daude (Cergy-Pontoise) and Francois Nicoleau (Nantes).

Sunday, April 7th (PHYSICS 130)

9:00 am: Josef Dorfmeister (TU-München)

- **Title**: Simple occurrences of the non-trivial sine-Gordon equation

- **Abstract**: In this talk we will start by explaining the occurrence of the "sine-Gordon equation" in geometry, physics, and textile manufacturing. In the second part of this talk, we will make the applications to geometry more explicit. Looking at surfaces of "Gauss curvature K = -1" in 3-space, i.e. surfaces looking locally like a saddle at each point, we will associate to each point a natural "tripod", two tangent vectors and a vector perpendicular to them. It will become clear (quite easily) how such a tripod induces the sine-Gordon equation, and, vice-versa, a solution to the sine-Gordon equation will induce a surface of Gauss curvature K = -1. We will at least indicate how all the solutions to the sine-Gordon equation discussed above can be constructed (using a generalization of the Gauss algorithm and the Gram-Schmidt algorithm). The discussion will be illustrated by several pictures of surfaces. In the (short) third part, time permitting, we will point out some open (to me) problems. Most of this talk should be accessible to any undergraduate student.

10:00 am: David Sattinger (Arizona)

- **Title**: Einstein meets Huygens: an optical view of general relativity
- **Abstract**: Huygens saw light as a wave-particle phenomenon — light was a wave propagated by "ethereal" particles. The mathematical basis for this

viewpoint is the symplectic geometry developed by Hamilton and Jacobi in the 19th century. The relativistic version of Hamilton-Jacobi's theory is used to show that the Einstein field equations are equivalent to a Hamiltonian system with 4 degrees of freedom.

11:30 am: Michael Gekhtman (Notre Dame)

- **Title**: Cluster integrable systems
- **Abstract**: Combinatorial structures imbedded into a definition of cluster algebras proved instrumental in reimagining many important integrable models and helped to discover new instances of complete integrability. The talk will provide an overview of an interaction between theories of cluster algebras and integrable systems with example ranging from dilogarithm identities to pentagram maps and their generalizations to discrete Toda-like systems that are close relatives of the peakon system to which a significant part of Jacek’s celebrated work is devoted.