Nonlinear Waves

workshop at UIC

Talks held in SEO 636
Department of Mathematics, Statistics, and Computer Science

Friday, November 9

3:00-4:00 **Guillaume Bal**, *University of Chicago.*

Title **Topological Insulators and obstruction to localization**.

Abstract **Topological insulators(TIs) are materials characterized by topological invariants. One of their remarkable features is the asymmetric transport observed at the interface between materials in different topological phases. Such transport is itself described by a topological invariant, and therefore "protected" against random perturbations. This immunity makes TIs extremely promising for many engineering applications and actively researched. In this talk, we present a PDE model for such TIs, introduce a topology based on indices of Fredholm operators, and analyze the influence of random perturbations. We confirm that topology is an obstruction to Anderson localization, a hallmark of wave propagation in strongly heterogeneous media in the topologically trivial case and to some extent quantify what is or is not protected topologically. For instance, a quantized amount of transmission is protected while back-scattering, a practical nuisance, is not**.

6:00 **Conference Dinner**, *Greek Town.*

Saturday, November 10

9:30-10:00 **Breakfest**, *SEO 636.*

10:00-11:00 **Tarek Elgindi**, *University of California at San Diego.*

Title **Singularity formation in incompressible fluids**.

Abstract **We will discuss recent results on singularity formation in finite and infinite time for the incompressible Euler equation and related models**.

11:00-12:00 **Alexis Vasseur**, *University of Texas-Austin.*

Title **The 3D Quasi-geostrophic equation: existence of solutions, lateral boundary conditions and regularity**.

Abstract **The 3D Quasi-geostropic equation is a model used in climatology to model the evolution of the atmosphere for small Rossby numbers. It can be derived from the primitive equation. The surface quasi-geostrophic equation (SQG) is a special case where the atmosphere above the earth is at rest. The evolution then depends only on the boundary condition, and can be reduced to a 2D model. In this talk, we will show how we can derive the physical lateral boundary conditions for the inviscid 3D QG, and construct global in time weak solutions. Finally, we will discuss the global regularity of solutions to the QG equation with Ekman pumping**.

12:00-2:00 **Lunch**, *Taylor St.*

2:00-3:00 **Zaher Hani**, *University of Michigan, Ann Arbor.*

Title **Strong nonlinear instability and growth of Sobolev norms near quasiperiodic finite-gap tori of the 2D cubic NLS**.

Abstract **We consider a family of quasiperiodic solutions of the nonlinear Schrodinger equation on the 2-torus, namely the family of finite-gap solutions (tori). These solutions are inherited by the 2D equation from its completely integrable 1D counterpart (NLS on the circle) by considering solutions that only depend on one variable. Despite being linearly stable, we prove that these tori (under some genericness conditions) are nonlinearly unstable in the following strong sense: there exists solutions that start very close to those tori in certain Sobolev spaces, but eventually become larger than any given factor at later times. This is the first instance where (unstable) long-time nonlinear dynamics near (linearly stable) quasiperiodic tori is studied and constructed. (joint work with M. Guardia (UPC, Barcelona), E. Haus (University of Naples), M. Procesi (Roma Tre), and A. Maspero (SISSA))**.

3:00-3:30 **Tea**, *SEO 636.*

3:30-4:30 **Mihaela Ifrim**, *University of Wisconsin-Madison.*

Title **A Morawetz inequality for water waves**.

Abstract **We consider gravity and gravity/capillary water waves in two space dimensions. Assuming uniform energy bounds for the solutions, we prove local energy decay estimates. Our result is uniform in the infinite depth limit**.

4:30-5:30 **Jason Murphy**, *Missouri University of Science and Technology.*

Title **Asymptotic stability of small solitary waves for the 1d NLS with a delta potential**.

Abstract **We consider the one-dimensional NLS with an attractive delta potential and mass-supercritical nonlinearity. In this case the equation admits a family of solitary waves, including small solitary waves that arise as small multiples of the linear bound state. We prove the asymptotic stability of these small solitary waves; that is, we prove that any small solution decouples into a solitary wave plus a dispersive part as times tends to infinity. This is joint work with S. Masaki and J. Segata**.

Sunday, November 11

9:30-10:00 **Breakfest**, *SEO 636*.

10:00-11:00 **Huy Nguyen**, *Brown University*.

Title **On the one-phase Muskat problem**.

Abstract **The one-phase Muskat problem models the dynamics of an interface between vacuum and a fluid in porous medium. We will discuss results on well-posedness, global existence, and maximum principles for this problem in all dimensions and in domains with general geometry. This is ongoing joint work with B. Pausader (Brown U.)**.

11:00-12:00 **Fabio Pusateri**, *Princeton University*.

Title **A proof of the Zakharov-Dyachenko conjecture for periodic gravity waves**.

Abstract **I will begin by introducing the water waves equations in the Hamiltonian setting and discuss some basic properties of this system. I will then present a joint work with M. Berti and R. Feola in which we give a rigorous proof of a conjecture of Zakharov and Dyachenko on the integrability up to order 4 of the gravity waves Hamiltonian in dimension 1. As a consequence, we also obtain a long-time existence result for small spatially periodic solutions, proving that these survive at least up to times of O(size of data)-3. This is the first such long-time existence result for quasilinear PDEs in the absence of external parameters**.

12:00-2:00 **Lunch**, *Taylor St*.

2:00-3:00 **Konstantina Trivisa**, *University of Maryland*.

Title **Invariant measures for the stochastic Navier-Stokes equations for compressible flows**.

Abstract **We investigate the long-time behavior of solutions to a stochastically forced one-dimensional Navier-Stokes system, describing the motion of a compressible viscous fluid. We prove existence of an invariant measure for the Markov process generated by strong solutions. We overcome the difficulties of working with non-Feller Markov semigroups on non-complete metric spaces by generalizing the classical Krylov-Bogoliubov method, and by providing suitable polynomial and exponential moment bounds on the solution, together with pathwise estimates.**.

3:00-3:30 **Tea**, *SEO 636*.