Nonlinear Wave Phenomena
Abstracts

Saturday 3:15 – 5:15
Natasa Pavlovic, The University of Texas at Austin
Magda Czubak, Binghamton University
Svetlana Roudenko, George Washington University
Lydia Bieri, University of Michigan, Ann Arbor

Sunday 8:30 – 10: 30
Anna Mazzucato, Penn State University
Vera Hur, University of Illinois, Urbana-Champaign
Xiaoyi Zhang, The University of Iowa
Sijue Wu, University of Michigan, Ann Arbor

Saturday 3:15 – 5:15

On the Gross-Pitaevskii hierarchies
Natasa Pavlovic, The University of Texas at Austin

The Gross-Pitaevskii (GP) hierarchy is an infinite system of coupled linear non-homogeneous PDEs, which appear in the derivation of the nonlinear Schr\"{o}dinger equation (NLS). Inspired by the PDE techniques that have turned out to be useful on the level of the NLS, we realized that, in some instances we can introduce analogous techniques at the level of the GP. In this talk we will discuss some of those techniques which we use to study well-posedness for GP hierarchies. The talk is based on joint works with T. Chen and with T. Chen and N. Tzirakis.

Title TBD
Magda Czubak, Binghamton University

We establish an interaction Morawetz estimate for the magnetic Schrodinger equation under certain smallness conditions on the gauge potentials. We discuss applications to wellposedness and scattering. This is joint work with J. Colliander and J. Lee.

Dynamics of blow up solutions to the focusing nonlinear Schroedinger equation
Svetlana Roudenko, George Washington University

I will consider the focusing NLS equation in one, two and three space dimensions with different powers of nonlinearities (including cubic and quintic powers) and their global solutions with finite energy initial data.

My discussion will focus on blow up solutions and known types of their dynamics. In particular, I will show that the class of so-called `log-log' blow up solutions can blow up not only on a single point set but on various geometric sets such as circles, spheres, cylinders, while remaining regular (in the energy space) away from the blow-up core.

From the Geometry of Einstein-Maxwell Spacetimes in General Relativity to Gravitational Radiation
Lydia Bieri, University of Michigan, Ann Arbor

A major goal of mathematical General Relativity (GR) and astrophysics is to precisely describe and finally observe gravitational radiation, one of the predictions of GR. In order to do so, one has to study the null asymptotical limits of the spacetimes for typical sources. Among the latter we find binary neutron stars and binary black hole mergers. In these processes typically mass and momenta are radiated away in form of gravitational waves. D. Christodoulou showed that every gravitational-wave burst has a nonlinear memory. In this talk, we discuss the null asymptotics for spacetimes solving the Einstein-Maxwell (EM) equations, compute the radiated energy and derive limits at null infinity and compare them with the Einstein vacuum (EV) case. The physical insights are based on geometric-analytic investigations of the solution spacetimes.

Sunday 8:30 – 10: 30

Boundary layers for channel and pipe flows
Anna Mazzucato, Penn State University

We present recent results concerning the vanishing viscosity limit and the analysis of the associated
boundary layer for certain classes of incompressible Couette flows in channels and pipes.

Uniqueness of solitary water waves
Vera Hur, University of Illinois, Urbana-Champaign

I will speak on the uniqueness issue of solitary waves on the free surface of a two-dimensional steady flow of water over a finite bed, acted upon by gravity. I will begin by a brief account of the solitary water wave problem as a nonlinear pseudo-differential equation involving the Dirichlet-Neumann operator. I will mention existence/non-existence of solutions. After briefing on the non-uniqueness and the instability results of waves near the extremal form, I will describe my recent work on the non-degeneracy of the linearized equation and its implication for uniqueness for small-amplitude waves.

Smooth global solutions for the two dimensional Euler-Poisson system

Xiaoyi Zhang, The University of Iowa

The Euler-Poisson system is a fundamental two-fluid model to describe the dynamics of the plasma consisting of compressible electrons and a uniform ion background. By using the dispersive Klein-Gordon effect, Yan Guo first constructed a global smooth irrotational solutions in the three dimensional case. It has been conjectured that same results should hold in the two dimensional case. The main difficulty in 2D comes from the slow dispersion of the linear flow and certain nonlocal

resonant obstructions in the nonlinearity. We develop a new method to overcome these difficulties and construct smooth global solutions for the 2D Euler-Poisson system.

A rigorous justification of the modulation approximation to the 2D full water wave problem

Sijue Wu, University of Michigan, Ann Arbor

We consider the 2D inviscid incompressible irrotational infinite depth water wave problem neglecting surface tension. Given wave packet initial data of the form $\varepsilon B(\varepsilon\alpha)e^{ik\alpha}$ for $k > 0$, we show that the modulation of the solution is a profile traveling at group velocity and governed by a focusing cubic nonlinear Schrodinger equation, with rigorous error estimates in Sobolev spaces. As a consequence, we establish existence of solutions of the water wave problem in Sobolev spaces for times of order $O(\varepsilon^{-2})$ provided the initial data differs from the wave packet by at most $O(\varepsilon^{3/2})$ in Sobolev spaces. These results are obtained by directly applying modulational analysis to the evolution equation with no quadratic nonlinearity constructed in [1] and by the energy method. This is a joint work with Nathan Totz.

[1] S. Wu. Almost global wellposedness of the 2-D full water wave problem. Invent. Math., 177(1):45–135, 2009.