The Fifth Oklahoma PDE Workshop

Oklahoma State University
February 28-March 1, 2015

Abstracts

1. **On a 1D model for equations in fluid mechanics**

   Tam Do, Rice University

   We give a brief overview of 1D models used to study fluid mechanics PDEs. We will then restrict most of our attention to a 1D model for SQG and Birkhoff-Rott equations and some of the recent results pertaining to this model.

2. **Double-exponential growth for smooth solutions of the 2D Euler equations**

   Vu Hoang, Rice university

   In this talk, I consider the 2D Euler equations. A well-known theorem states that the vorticity gradient grows at most with a double-exponential rate in time. An important question is whether this upper bound is attained by some smooth solution. In recent work by by A. Kiselev and V. Sverak, a solution is constructed that exhibits double-exponential gradient growth at the boundary, using the so-called hyperbolic flow scenario. I discuss the difficulties in constructing solutions having the required growth at an interior point, as well as a recent no-go theorem (joint work with M. Radosz) for hyperbolic flows in the interior.

3. **On conditional and partial regularity for the Navier-Stokes equations**

   Igor Kukavica, University of Southern California

   We will address several problems connected to the regularity question of the Navier-Stokes system. In the first part, we will construct some special data with a large BMO^{-1} norm for which global solutions exist. In the second part, we will partial regularity for the Navier-Stokes system. Most results are joint with W. Rusin and M. Ziane.

4. **The fractional Landau-Lifshitz equation without damping term and fractional Ginzburg-Landau equation**

   Jingna Li, Jinan University and Oklahoma State University

   The talk is concerned with real fractional Landau-Lifshitz equation and Ginzburg-Landau equation. Existence and uniqueness of local and global mild solution with distributional initial data are obtained by viscocity approximation and contraction mapping principle respectively. By carefully choosing the working space, Gevrey

regularity of mild solution of the fractional Landua-Lifshitz equation for flat torus case is discussed.

5. **The primitive equations with partial dissipation**

   Jinkai Li, The Weizmann Institute of Science and Texas A&M University

   The primitive equations form a fundamental block in the models of oceanic and atmospheric dynamics. They are derived from the Navier-Stokes equations by applying the Boussinisq and hydrostatic approximations. Generally the viscosities and diffusion for the ocean and atmosphere are anisotropic. In this talk, I will talk about the global well-posedness of strong solutions to the primitive equations with only partial dissipation. These are joint works with Chongsheng Cao and Edriss S. Titi.

6. **Finite determining parameters feedback control for distributed nonlinear dissipative systems – a computational study**

   Evelyn Lunasin, U.S. Naval Academy

   We present a numerical study of a new algorithm for controlling general dissipative evolution equations using determining systems of parameters like determining modes, nodes and volume elements. We implement the feedback control algorithm for the Chafee-Infante equation, a simple reaction diffusion equation and the Kuramoto-Sivashinsky equation, a model for flame front propagation or flowing thin films on inclined surface. Other representative applications include catalytic rod, chemical vapor deposition and other defense-related applications. We also discuss stability analysis for the feedback control algorithm and derive sufficient conditions, for the stabilization,, relating the relaxation parameter, number of controllers and sensors, and other model parameters (joint work with Edriss S. Titi).

7. **Cauchy problem for nonlinear parabolic equations with a gradient term**

   Haifeng Shang, Henan Polytechnic University and Oklahoma State University

   In this talk, we will present some our study on the Cauchy problem for the nonlinear parabolic equation with gradient source term. Based on a priori estimates, De Giorgi's iteration and techniques in real analysis, the existence and nonexistence of local and global solutions are established. In particular, a Fujitas type critical exponent is obtained.

8. **Wave Breaking for a system of Shallow Water**

   Lizheng Tao, UIUC

   In this talk, we discuss the regularity property for a system derived from shallow water models. The system processes a dispersive operator according to Whitham's

model. A wave breaking result is obtained given the initial data satisfying some large criteria.

9. **Is Dispersion a Stabilizing or Destabilizing Mechanism?**

`Edriss S. Titi`, The Weizmann Institute of Science and Texas A&M University

In this talk I will present a united approach for the effect of fast rotation and dispersion as an averaging mechanism for, on the one hand, regularizing and stabilizing certain evolution equations, such as the Navier-Stokes and Burgers equations. On the other hand, I will also present some results in which large dispersion acts as a destabilizing mechanism for the long-time dynamics of certain dissipative evolution equations, such as the Kuramoto-Sivashinsky equation.

10. **Weighted decay for the surface quasi-geostrophic equation**

`Fei Wang`, University of Southern California

We address the weighted decay for the solution of the surface quasi-geostrophic (SQG) equation which is given by

$$\theta_t + u \cdot \nabla\theta + \Lambda^{2\alpha}\theta = 0$$

where $\Lambda = (-\Delta)^{1/2}$. The firrst moment decay $\||x|\theta\|_{L^2}$ was obtained by M. and T. Schonbek in their paper "Moments and lower bounds in the far-field of solutions to quasi-geostrophic ows". Here we obtain the decay rates of $\||x|^b\theta\|_{L^2}$ for any $b \in (0,1)$ and the rate of increase of this quantity for $b \in [1; 1+\alpha)$ under natural assumptions on the initial data.

11. **Some recent results on the global well-posedness of Boussinesq systems**

`Xiaojing Xu`, Beijing Normal University, Beijing, China

In this talk, we will give some recent results on the global well-posedness of Boussinesq with some kinds of dissipation terms, including the subcritical and critical fractional Laplacian, damping, partial viscosity and viscosity depending on temperature.

12. **Mixing of passive scalars advected by incompressible enstrophy-constrained flows**

`Xiaoqian Xu`, University of Wisconsin at Madison

Consider a diffusion-free passive scalar θ being mixed by an incompressible flow u on the torus $\mathbf{T}^d$. Our aim is to study how well this scalar can be mixed under an enstrophy constraint on the advecting velocity field. Our main result shows that the mix-norm ($||\theta(t)||_{H^{-1}}$) is bounded below by an exponential function of time. We will also perform numerical simulations and confirm that the numerically observed decay rate scales similarly to the rigorous lower bound, at least for a significant

initial period of time. This is the joint work with Gautam Iyer and Alexander Kiselev.

13. **Recent developments on the micropolar and magneto-micropolar fluid systems: deterministic and stochastic perspectives**

`Kazuo Yamazaki`, Washington State University

We review recent developments on the micropolar and magneto-micropolar fluid systems. These are systems of PDEs that resemble the Navier-Stokes equations and magnetohydrodynamics system but also have distinctive features in particular from the Boussinesq system that makes its mathematical analysis of much interest and great challenge. The results to be discussed include the following: in the deterministic case, the global regularity result in 2D space with zero angular viscosity and a regularity criterion in 3D space that involves two velocity vector field components and in the stochastic case, the existence of a weak martingale solution in 3D space and the unique strong solution in 2D space under a suitable condition on the noise.