Evolution Equations and Friends, 6 October 2017

## Abstracts

Jamie Bennett
*Large Scale Patterns in Mussel Beds: Stripes or Spots?*

Mussel beds are common in intertidal regions and often form interesting pattern formations. This can be explained by a 'reduced losses' theory. In this talk, I will explain the origin of striped patterns, and show how they are linked to spotted patterns through numerical bifurcation analysis and simulation of a PDE model.

Mayank Drolia
*Enriched finite elements for initial value problems in wave propagation*

We find problems involving wave phenomena routinely in our daily lives, for example when listening to music or turning on the light we encounter waves. To be able to accurately predict the behavior of waves it is necessary to design tools. There is a plethora of methods to achieve that, for example finite differences and finite elements. As the frequency of wave increases, the problem gets increasingly challenging to obtain engineering accuracy results within practical computational costs. This research focuses on cost-reduction in the numerical analysis of waves, using special enrichment functions for finite elements. The example problems dealt with focus on TE mode propagation of light waves in vacuum.

Gissell Estrada-Rodriguez
*Fractional Patlak-Keller-Segel equations for chemotactic superdiffusion*

The long range movement of certain organisms in the presence of a chemoattractant can be governed by long distance runs, according to an approximate Levy distribution. This article clarifies the form of biologically relevant model equations: We derive Patlak-Keller-Segel-like equations involving nonlocal, fractional Laplacians from a microscopic model for cell movement. Starting from a power-law distribution of run times, we derive a kinetic equation in which the collision term takes into account the long range behaviour of the individuals. A fractional chemotactic equation is obtained in a biologically relevant regime. Apart from chemotaxis, our work has implications for biological diffusion in numerous processes.

Stefania Lisai
*Semi-geostrophic equations*

I am going to give an introduction to the semi-geostrophic equations (SG), obtained as an asymptotic limit of the Navier-Stokes equations. Through a change of variables, the system of equations can be written and studied in a dual formulation, which is given by a transport equation coupled with a Monge-Ampre equation, and we will focus on the ground-breaking work of Benamou and Brenier in 1998, who proved existence of weak solutions for the dual system. We will talk about a 2-D simplification of SG, called Surface SG, and we will also present Cullen's stability principle.

Prince Romeo Mensah
*The Incompressible limit of the Compressible Navier–Stokes equation*

A fundamental question in compressible fluid mechanics is the relation to the incompressible model. If the Mach number - representing the ratio between the average flow velocity and the speed of sound - is small, the fluid should behave asymptotically like an incompressible one. This short talk will give the main ideas of the mathematical justification for this problem using a singular limit argument.

David Stark
*Time-domain boundary elements for wave propagation*

Efficient and accurate computational methods for wave equations are of interest in real-world engineering problems such as environmental noise and sound emission of car tires. We reduce the wave equation to an integral equation on the boundary of domain and discuss a time domain boundary element method for its numerical solution. The resulting methods have been shown to be stable and accurate for long-time simulations and are competitive with the popular frequency domain methods. We focus on problems involving singular geometries in $\mathbb{R}^3$. Similar to work by Kondratiev and Dauge in the elliptic (time-harmonic) case, we discuss the asymptotic behaviour of the solution to the time-dependent wave equation near corners and edges. The asymptotics are verified numerically; they give rise to efficient discretisations on algebraically graded meshes with optimal convergence rates. We furthermore discuss adaptive schemes based on a computable (a posteriori) error estimate which provides a provable upper bound to the error. We investigate these two mesh-refinement approaches and illustrate them in numerical experiments. We also discuss relevant algorithmic issues concerning the efficient implementation of these schemes.

Jakub Stoček
*Finite elements for fractional obstacle problems*

Fractional obstacle problems naturally arise in finance and biology for random walks driven by a pure jump Lévy process. I will discuss finite element discretization as well as a priori and a posteriori error analysis.

Antonis Ververis
*Approaching Thermodynamic Equilibrium: From the Cahn-Hilliard Equation to the General Evolution Equations for Irreversible-Reversible Coupling*