Workshop on

PDE Problems Arising From Biology and Related Area

Partial differential equation (PDE) is one of the major tools to connect mathematical theories to real world. The PDE theory has been advanced enormously in the past a few decades and plays a prominent role to understand the underlying mechanism of various real-life phenomena and practical problems. In particular, the PDE problems arising from biology and related area have been widely produced and studied over the past three decades and have now becomes one of the hottest topics in applied mathematics. The purpose of this workshop is to bring together mathematicians from various branches of PDEs and mathematical biology to exchange their ideas and engage more collaboration.

Date: 18-19 August 2015
Venue: Meeting Room TU 801

Invited Speakers:

Renjun Duan	Chinese University of Hong Kong
Daihai He	Hong Kong Polytechnic University
Haiyang Jin	South China University of Technology, China
Tong Li	University of Iowa, USA
Jingyu Li	Northeast Normal University, China
Wing Cheong LO	City University of Hong Kong, Hong Kong
Yijun Lou	Hong Kong Polytechnic University
Min Tang	Shanghai Jiaotong University, China
Youshan Tao	Donghua University, China
Chunhua Ou	Memorial University of Newfoundland, Canada
Lihe Wang	University of Iowa, USA
Xiangsheng Wang	Southeast Missouri State University, USA
Xiaojing Xu	Beijing Normal University, China
Zhaoyin Xiang	University of Electronic Science and Technology of China
Gaofeng Zheng	Central China Normal University, China

Sponsor: The AMSS-PolyU Joint Research Institute and PolyU

The transportation from Hong Kong/Shenzhen airport to the Harbour Plaza Metropolis hotel and Hong Kong Polytechnic University

If you are traveling from the Hong Kong International Airport, there are four possible ways to get to the hotel as follows:

- **By City Bus** (HK$ 33 per person): Following the sign after getting out the exit (i.e. pick up area) in the arrival hall and then follow the sign to take the City Bus A21. It takes about 50 minutes. Please get off the bus at Hung Hom station (terminal of the bus) and then walk to the Harbour Plaza Metropolis hotel by about 5 minutes. Highly recommend if you want to save money. The view is beautiful along the bus route.
- **By Hotel-Link Shuttle Bus** (HK$ 130 per person): When you get out the exit in the Arrival Hall, please approach Counter B01 which is opposite to EXIT B and then show your hotel information to the staff. After purchasing the ticket there, you will be led by the staff to get on the shuttle bus. This shuttle bus takes you to the Harbour Plaza Metropolis hotel directly.
- **By airport express train** (HK$ 90): First take the airport express train to Kowloon station. After getting out the exit at Kowloon station, then follow the sign to take free transit bus K1 to the hotel directly.
- **By Urban taxis (Red)**, which costs approximately HK$ 280.

If you are traveling from the Shenzhen International Airport, then

- Please take taxi (or airport shuttle bus 330) to Lo Wu station. After cross the border control, take the East Rail Line train (which is also the only train) to Hung Hom station which is the terminus of this line. Please get out from EXIT C at Hung Hom station and then walk to the hotel directly (5 minutes), or EXIT A/B to Hong Kong Polytechnic University

Department of Applied Mathematic
Hong Kong Polytechnic University

Workshop on ``PDE Problems Arising from Biology and Related Area''

August 18-19, 2015

Venue: Room TU801, 8/F, Core T, Yip Kit Chuen Building, PolyU

Program

Day 1	August 18, 2015 (Tuesday)
08:50-9:00	Opening remarks
Session Chair	*Youshan Tao*
09:00-09:45	**Wang Lihe** Geometry and regularity of solutions of elliptic equations
09:45-10:30	**Xiaojing Xu** Some recent results on the global well-posedness of Boussinesq system
10:30-10:50	Coffee and Tea Break
Session Chair	*Zhaoyin Xiang*
10:50-11:35	**Gaofeng Zheng** Maxwell's Equations in an Unbounded Structure
11:35-12:20	**Jingyu Li** Viscosity dominated limit for a hyperbolic equation in MEMS
12:20-14:00	Lunch at 南北小厨 (on campus)
Session Chair	*Tong Li*
14:00-14:45	**Chunhua Ou** Global stability of monostable traveling waves for nonlocal time-delayed reaction-diffusion equations
14:45-15:30	**Renjun Duan** A kinetic flocking model with diffusion
15:30-15:50	Coffee and Tea Break
Session Chair	*Chunhua Ou*
15:50-16:35	**Xiangsheng Wang** Traveling waves of a diffusive Kermack-McKendrick SIR model
16:35-17:20	**Min Tang** Traveling wave solution of the Hele–Shaw model of tumor growth with nutrient
17:20-18:00	**Wing-Cheong Lo** Pattern in a cell: Modeling cell polarization in budding yeast
18:30-20:30	**Dinner at 煌府婚宴 （置富都会商场 7 楼 776-778 铺）**

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Program

Day 2	August 19, 2015(Wednesday)
Session Chair	*Zhian Wang*
09:00-09:45	**Youshan Tao** Boundedness and decay of classical solutions in a multi-dimensional chemotaxis-fluid system
09:45-10:30	**Zhaoyin Xiang** Global existence and boundedness in a Keller-Segel-Stokes system involving a tensor-valued sensitivity
10:30-10:50	Coffee and Tea Break
Session Chair	*Xiaojing Xu*
10:50-11:35	**Tong Li** Global well-posedness and traveling wave solutions of PDE models of chemotaxis
11:35-12:20	**Haiyang Jin** Attraction-repulsion chemotaxis model and its applications
12:20-14:00	Lunch at Bistro 1997 in Icon Hotel
14:00-16:00	**Free Discussion Led by Daihai He and Yijun Lou**

Title and Abstract:

A kinetic flocking model with diffusion
Renjun Duan
Chinese University of Hong Kong

We study the stability of the equilibrium states and the rate of convergence of solutions towards them for the continuous kinetic version of the Cucker-Smale flocking in presence of diffusion whose strength depends on the density. This kinetic equation describes the collective behavior of an ensemble of organisms, animals or devices which are forced to adapt their velocities according to a certain rule implying a final configuration in which the ensemble flies at the mean velocity of the initial configuration. Our analysis takes advantage both from the fact that the global equilibrium is a Maxwellian distribution function, and, on the contrary to what happens in the Cucker-Smale model, the interaction potential is an integrable function. Precise conditions which guarantee polynomial rates of convergence towards the global equilibrium are found. In the end we propose some mathematical problem on the model related to existence and stability of profiles with phase transition.

Attraction-repulsion chemotaxis model and its applications
Haiyang Jin
South China University of Technology

In this talk, we shall consider an attraction-repulsion Keller-Segel (ARKS) model proposed in 2003 to describe the aggregation of microglia cells formed in the central nervous system in Alzheimer's disease. The recent progress on the global dynamics of solutions of the ARKS model will be reported and some new insights and open problems will be discussed.

Viscosity dominated limit for a hyperbolic equation in MEMS
Jingyu Li
Northeast Normal University

We consider a damped wave equation with singular nonlinearity and Dirichlet boundary condition in a bounded domain. This equation models an electrostatic micro-electro-mechanical system (MEMS) device. We first show that the pull-in voltage is the critical threshold for global existence and quenching in this wave equation. More precisely, if the applied voltage is smaller than the critical value, then the equation admits a unique global small solution that exponentially converges to the minimal steady state. If the applied voltage is larger than the critical value, then any solution quenches in finite time. We also analyze the relationship between the hyperbolic model and the parabolic model through the viscosity dominated limit. We show that, in one-dimensional case, in this singular limit the solution of the hyperbolic model converges to that of the parabolic one globally in time. Also the higher order terms including the initial layer corrections, as well as the related error estimates, are derived. Furthermore, it is proved that the convergence is valid for global solutions with large initial data.

Global Wellposedness and Traveling Wave Solutions of PDE Models of Chemotaxis
Tong Li
University of Iowa

We investigate local and global existence, blowup criterion and long time behavior of classical solutions for a system of PDEs derived from the Keller-Segel model describing chemotaxis. Moreover, we establish the existence and the nonlinear stability of large-amplitude traveling wave solutions to the system of nonlinear conservation laws derived from Keller-Segel model.

Pattern in a cell: Modeling Cell Polarization in Budding Yeast
Wing-Cheong Lo
City University of Hong Kong

Robust cell polarity is critical for cell survival and normal tissue development. Cell polarity is usually induced through the localization of specific molecules to a proper location of the cell membrane. Here we propose a generic model consisting the particle density of membrane bound molecules undergoing polarization to study the mechanisms for different budding patterns in yeast cells.

Global Stability of Monostable TravelingWaves For Nonlocal Time-Delayed Reaction-Diffusion Equations
Chunhua Ou
Memorial University of Newfoundland, Canada

For a class of nonlocal time-delayed reaction-diffusion equations, we prove that all noncritical wavefronts are globally exponentially stable, and critical wavefronts are globally algebraically stable, when the initial perturbations around the wavefront decay to zero exponentially near the negative infinity regardless of the magnitude of time delay. This work also improves and develops the existing stability results for local and nonlocal reaction-diffusion equations with delays. Our approach is based on the combination of the weighted energy method and the Green function technique.

Traveling wave solution of the Hele–Shaw model of tumor growth with nutrient
Min Tang
Shanghai Jiaotong University

Several mathematical models of tumor growth are now commonly used to explain medical observations and predict cancer evolution based on images. These models incorporate mechanical laws for tissue compression combined with rules for nutrients availability which can differ depending on the situation under consideration, in vivo or in vitro. Numerical solutions exhibit, as expected from medical observations, a proliferative rim and a necrotic core. However, their precise profiles are rather complex, both in one and two dimensions. We study a simple free boundary model formed of a Hele–Shaw equation for the cell number density coupled to a diffusion equation for a nutrient. We can prove that a traveling wave solution exists with a healthy region separated from the progressing tumor by a sharp front (the free boundary) while the transition to the necrotic core is smoother. Remarkable is the pressure distribution which vanishes at the boundary of the proliferative rim with a vanishing derivative at the transition point to the necrotic core.

Boundedness and decay of classical solutions in a multi-dimensional chemotaxis-fluid system

Youshan Tao
Donghua University

This talk addresses a newly proposed Keller-Segel-Navier-Stokes system modeling the phenomenon of broadcast spawning, such as the coral spawning, in which eggs release a chemical that attracts sperm. We study basic mathematical features of such a model for chemotaxis-fluid interaction. More precisely, under some explicit parameter conditions, the boundedness and decay of a classical solution to the corresponding initial-boundary problem is explored in two- and three-dimensional settings. This is a joint work with Michael Winkler (Paderborn).

Geometry and regularity of solutions of elliptic equations

Lihe Wang
University of Iowa

We will talk about the interplay between the regularity of the solutions and the the geometric properties of the domains of equations.
Particularly the regularity for degenerate equations and domains with corners shall have wide applications in practice and applications.

Traveling waves of a diffusive Kermack-McKendrick SIR model

Xiang-Sheng Wang
Southeast Missouri State University

We study the existence and nonexistence of traveling waves of a diffusive Kermack-McKendrick SIR model with standard incidence where the total population is not constant. We show that the minimum wave speed of traveling waves for the three-dimensional non-monotonic system can be derived from its linearization at the disease-free equilibrium. The proof is based on Schauder fixed point theorem and Laplace transform. This is a joint work with Haiyan Wang of Arizona State University.

Global existence and boundedness in a Keller-Segel-Stokes system involving a tensor-valued sensitivity

Zhaoyin Xiang
University of Electronic Science and Technology of China

In this talk, we investigate the 2D Keller-Segel-Stokes system in a bounded domain. Due to the appearance of the matrix-valued chemotactic sensitivity, this system does not possess any gradient-like structure. To establish the global existence and boundedness of solutions, we will derive a series of *a priori* estimates involving a new interpolation inequality. This is a joint work with Xie Li and Yulan Wang.

Some recent results on the global well-posedness of Boussinesq system

Xiaojing Xu
Beijing Normal University

In this talk, I 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.

Maxwell's Equations in an Unbounded Structure

Gaofeng Zheng

Central China Normal University

We are concerned with the electromagnetic wave scattering by an unbounded dielectric medium, which is mounted on a perfectly conducting infinite plane. By introducing a transparent boundary condition on a plane surface confining the medium, the scattering problem is modeled as a boundary value problem of Maxwell's equations. Based on a variational formulation, the problem is shown to have a unique weak solution for a wide class of dielectric permittivity by using the generalized Lax-Milgram theorem.