Workshop on

“PDE Problems in Mathematical Biology and Physics”

June 22-23, 2012

Department of Applied Mathematics,
The Hong Kong Polytechnic University
Hong Kong

Sponsors:

AMSS-PolyU Joint Research Institute
Hong Kong Mathematical Society
Department of Applied Mathematics, PolyU

Enquiry:

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Transportation and Internet

1. **The transportation** from Hong Kong/Shenzhen airport to the *Harbour Plaza Metropolis Hotel* and *Hong Kong Polytechnic University*:

   (1) If you are traveling from the **Hong Kong International Airport**, there are four options available as follows:

   (a) 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 (free Wifi available on bus). Please get off the bus at Hung Hom station which is also the terminus of the bus and then walk to the Harbour Plaza Metropolis Hotel (about 5 minutes). Highly recommend if you like to take a bus tour. It takes about 50 minutes.

   (b) 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.

   (c) 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.

   (d) By Urban taxis (Red), which costs approximately HK$ 280.

   (2) If you are traveling from the **Shenzhen International Airport**, then please take taxi (or airport shuttle bus) to Lo Wu station. After cross the border control, take the East Rail Line train to Hung Hom station which is the terminus of this train. Please get out from EXIT C at Hung Hom station and then walk to the hotel directly (5 minutes), or EXIT A to Hong Kong Polytechnic University.

2. **Wifi internet access** in Hong Kong Polytechnic University:

   SSID: PolyUWLAN (on campus) or Universities via Y5ZONE (off campus)

   Username: tmpwifi (on campus) or tmpwifi@polyu.edu.hk (off campus)

   Password: Ama12345
## Programme

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| 09:00-09:45 | Jun-Cheng WEI  
On $SU(n+1)$ Toda system: classification and applications |
| 09:45-10:30 | Junping SHI  
Non-local logistic type equation |
| 10:30-11:00 | Tea Reception |
| Session Chair | Junping Shi |
| 11:00-11:45 | Xiaoqiang ZHAO  
Effects of diffusion and advection on the principal eigenvalue of a periodic parabolic problem with applications |
| 11:45-12:30 | Wenzhang HUANG  
Traveling wave solutions for a class of Predator-Prey system |
| 12:30-14:15 | Workshop Lunch |
| Session Chair | Zhian Wang |
| 14:15-15:00 | Xiao-Ping WANG  
Analysis of contact angle hysteresis |
| 15:00-15:45 | Renjun DUAN  
Global solutions to the coupled chemotaxis-fluid equations |
| 15:45-16:15 | Tea Reception |
| Session Chair | Wenzhang Huang |
| 16:15-17:00 | Daihai HE  
Investigating the causes of the three waves of the 1918 influenza pandemic in England and Wales |
| 17:00-17:45 | Xing LIANG  
Traveling waves for the monostable and bistable models with free boundary |
| 18:30 | Workshop Dinner (4th floor of Communal building) |
Department of Applied Mathematics  
Hong Kong Polytechnic University  

**Workshop on PDE Problems in Mathematical Biology and Physics**  
June 22, 2012 (Friday) – June 23, 2012 (Saturday)  
Venue: Room HJ610, 6/F, Core J, Stanley Ho Building, PolyU

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## Programme

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| 09:15-10:00 | **Tong YANG**  
Some limits to compressible Euler equations-one space dimensional problem |
| 10:00-10:45 | **Huijiang ZHAO**  
One-dimensional compressible Navier-Stokes equations with density and temperature dependent transport coefficients |
| 10:45-11:15 | **Tea Reception** |
| Session Chair | Xing Liang |
| 11:15-12:00 | **Xianjin CHEN**  
A numerical method for finding multiple solutions to elliptic systems with nonlinear boundary conditions |
| 12:00-12:45 | **Tong LI** (pending)  
Nonlinear dynamics of chemotaxis |
| 13:00-15:00 | **Workshop Lunch** |
| 15:00-17:00 | **Discussion** |
A numerical method for finding multiple solutions to elliptic systems with nonlinear boundary conditions

Xianjin CHEN
Department of Mathematics
University of Science and Technology of China
Hefei, China

Abstract

Saddle points appear as unstable equilibria or transient states in many physical or chemical systems. Many studies in convection-diffusion systems, corrosion/oxidation modeling, metal-insulator or metal-oxide semiconductor systems may lead to semilinear elliptic systems subject to nonlinear boundary conditions (NBC). In particular, coexisting states are of special interest in the study of the interaction of two different particles or species in those systems. In this talk, a local characterization on saddle points for dual functionals is proposed. Then, a numerical method for finding multiple coexisting states to semilinear elliptic systems with NBC is developed. In the end, some numerical examples are presented.

Global solutions to the coupled chemotaxis-fluid equations

Renjun DUAN
Department of Mathematics
Chinese University of Hong Kong, Hong Kong

Abstract

This talk is concerned with a biological system of the chemotaxis equations coupled with the viscous incompressible fluid equations through transport and external forcing. The global-in-time existence of solutions to the Cauchy problem in three space dimensions is established under certain conditions. Precisely, for the chemotaxis-Navier-Stokes system, we obtain global existence and convergence rates of classical solutions near constant states. When the fluid motion is described by Stokes equations, we derive some free energy functionals to prove global existence of weak solutions for cell density with finite mass, first-order spatial moment and entropy provided that the potential is weak or the substrate concentration is small. Some recent results related to the current work will be mentioned in the end. This is a joint work with A. Lorz and P. A. Markowich.
Investigating the causes of the three waves of the 1918 influenza pandemic in England and Wales

Daihai HE
Department of Applied Mathematics,
The Hong Kong Polytechnic University
Hong Kong

Abstract
Past influenza pandemics appear to be characterized by multiple waves of incidence but the mechanisms that account for this phenomenon remain unclear. We proposed a simple epidemic model in which we incorporate three factors that might contribute to the generation of multiple waves: (i) schools opening and closing, (ii) temperature changes during the outbreak, and (iii) changes in human behavior in response to the outbreak. We fitted this model to the reported influenza mortality data of the 1918 pandemic from 334 UK administrative units, and estimated the epidemiological parameters. We then use information criteria to identify which of the three factors provides the best explanation for the multiple waves seen in the data. Our results suggest that all three factors are important and that, taken together, a model with these factors can produce epidemiological dynamics that match the data well for reasonable parameter values.

(Joint work with David Earn, Jonathan Dushoff, Troy Day and Junling Ma)

Traveling wave solutions for a class of predator-prey systems

Wenzhang HUANG
Department of Mathematical Sciences
University of Alabama in Huntsville
Huntsville, AL 35899 USA

Abstract
A class of diffusive models of predator-prey interaction is considered. The models contain two boundary equilibrium states, $E_0 = 0$ and $E_b$, and an interior (co-existence) equilibrium state $E_i$, where $E_b$ is a state of the absence of predator species. Our interest is to study the transitions from the boundary equilibrium states to the interior equilibrium state, which are described by traveling wave fronts. A shooting method, combined with a Liapunov function, is developed to investigate the existence of traveling wave fronts. With this method we are able to find precise ranges of wave speeds for the existence of wave solutions connecting $E_0$ and $E_b$, and connecting $E_0$ and $E_i$, respectively. It is interesting to mention that our results indicate that for a given wave speed, these two types of traveling wave solutions can not co-exist. Our approach is a significant improvement of techniques introduced by Dunbar. Our method provides a more efficient way to study the existence of traveling wave solutions for more general predator-prey systems.
Nonlinear dynamics of chemotaxis

Tong LI
Department of Mathematics
University of Iowa
Iowa City, IA 52242, USA

Abstract

We study nonlinear dynamics of quasilinear hyperbolic-parabolic systems derived from the Keller-Segel model describing chemotaxis. In particular, global wellposedness, blowup criterion and long time behavior of solutions are investigated. Moreover, existence and nonlinear stability of large-amplitude traveling wave solutions were established.

Traveling waves for the monostable and bistable models with free boundary

Xing LIANG
Department of Mathematics
University of Science and Technology of China
Heifei, China

Abstract

Traveling waves for the monostable and bistable models with free boundary in space periodic habitat are studied. The existence, uniqueness and asymptotical behavior of the periodic traveling waves is given.
Non-local logistic type equation

Junping SHI
Department of Mathematics
College of William and Mary
Williamsburg, Virginia, USA

Abstract

Logistic type equations have been classical models in mathematical biology, and Fisher-KPP equation combines the passive diffusion and logistic growth. In recent years, it has been recognized that the growth rate per capita may have a nonlocal dependence on the population, and delay effect may also be included. We consider several models to incorporate these additional effect. We consider the existence and uniqueness of the positive steady state solution, and associated stability properties under different dynamics. For a nonlocal delayed reaction-diffusion model, the stability of the positive spatially nonhomogeneous positive equilibrium and associated Hopf bifurcation are investigated for the case of near equilibrium bifurcation point and the case of spatially homogenous dispersal kernel. The talk reports several joint work with Shanshan Chen, Jun Zhou, Linan Sun and Yuwen Wang.

Analysis of contact angle hysteresis

Xiao-Ping WANG
Department of Mathematics
Hong Kong University of Science and Technology
Hong Kong

Abstract

We analyze the wetting hysteresis on rough and chemically patterned surfaces from a phase-field model for two phase fluid. In the slow motion, the dynamic of the contact angle can be derived from the matched asymptotic expansions. The contact angle hysteresis is then studied by homogenization as the size of the pattern becomes small.
On SU($n+1$) Toda system: classification and applications

Jun-Cheng WEI
Department of Mathematics
Chinese University of Hong Kong, Hong Kong

Abstract

We give a complete classification of all solutions to the following Toda system

$$\Delta u_i + \sum_{j=1}^{n} a_{ij} e^{u_j} = 4\pi \gamma_i \delta_0 \text{ in } \mathbb{R}^2, \quad \int_{\mathbb{R}^2} e^{u_i} dx < \infty, \quad \forall 1 \leq i \leq n,$$

where $\gamma_i > -1$, $\delta_0$ is Dirac measure at 0, and the coefficients $a_{ij}$ form the standard Cartan matrix $A_n$. Then we present two applications of the classifications: first we construct non-topological solutions to the nonabelian SU(3) and $B_2$ Chern-Simons system. Then we analyze the bubbling behavior of the Toda system on a Riemann surface. (Joint work of CSLin-Ye, Ao-CSLin, CSLin-Zhao).

Some limits to compressible Euler equations-one space dimensional problem

Tong YANG
Department of Mathematics
City University of Hong Kong
Hong Kong

Abstract

In this talk, we will present some recent works about the limits to the compressible Euler equations in one space dimension from the system with artificial viscosity, Navier-Stokes equations and the Boltzmann equation.
One-dimensional compressible Navier-Stokes equations with density and temperature dependent transport coefficients

Huijiang ZHAO  
School of Mathematics and Statistics  
Wuhan University  
Wuhan 430072, China

Abstract

This talk is concerned with the construction of non-vacuum global smooth solutions to the one-dimensional compressible Navier-Stokes equations with density and temperature dependent transport coefficients. Three types of global solvability results with large data will be presented.

Effects of diffusion and advection on the principal eigenvalue of a periodic parabolic problem with applications

Xiaoqiang ZHAO  
Department of Mathematics  
Memorial University of Newfoundland  
Canada

Abstract

The principal eigenvalue is a basic concept in the field of parabolic partial differential equations. In recent decades, a large amount of research works have been devoted to the study of qualitative properties of the principal eigenvalue and its eigenfunction for second-order linear elliptic operators. As far as the nonautonomous periodic-parabolic operator is concerned, however, much less has been known for the associated principal eigenvalue, especially when the advection term appears. The principal eigenvalue for linear periodic-parabolic operators becomes important when a time periodic environment is involved. In this talk, I will report our recent research on a one-dimensional periodic-parabolic eigenvalue problem. The dependence of the principal eigenvalue on the diffusion and advection coefficients is investigated. In particular, the asymptotic behaviors of the principal eigenvalue are derived as these two coefficients approach zero or infinity. Our obtained results are then applied to a nonlocal reaction-diffusion-advection equation modelling the spatio-temporal evolution of a single phytoplankton species with periodic incident light intensity. This talk is based on a joint work with Rui Peng.