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

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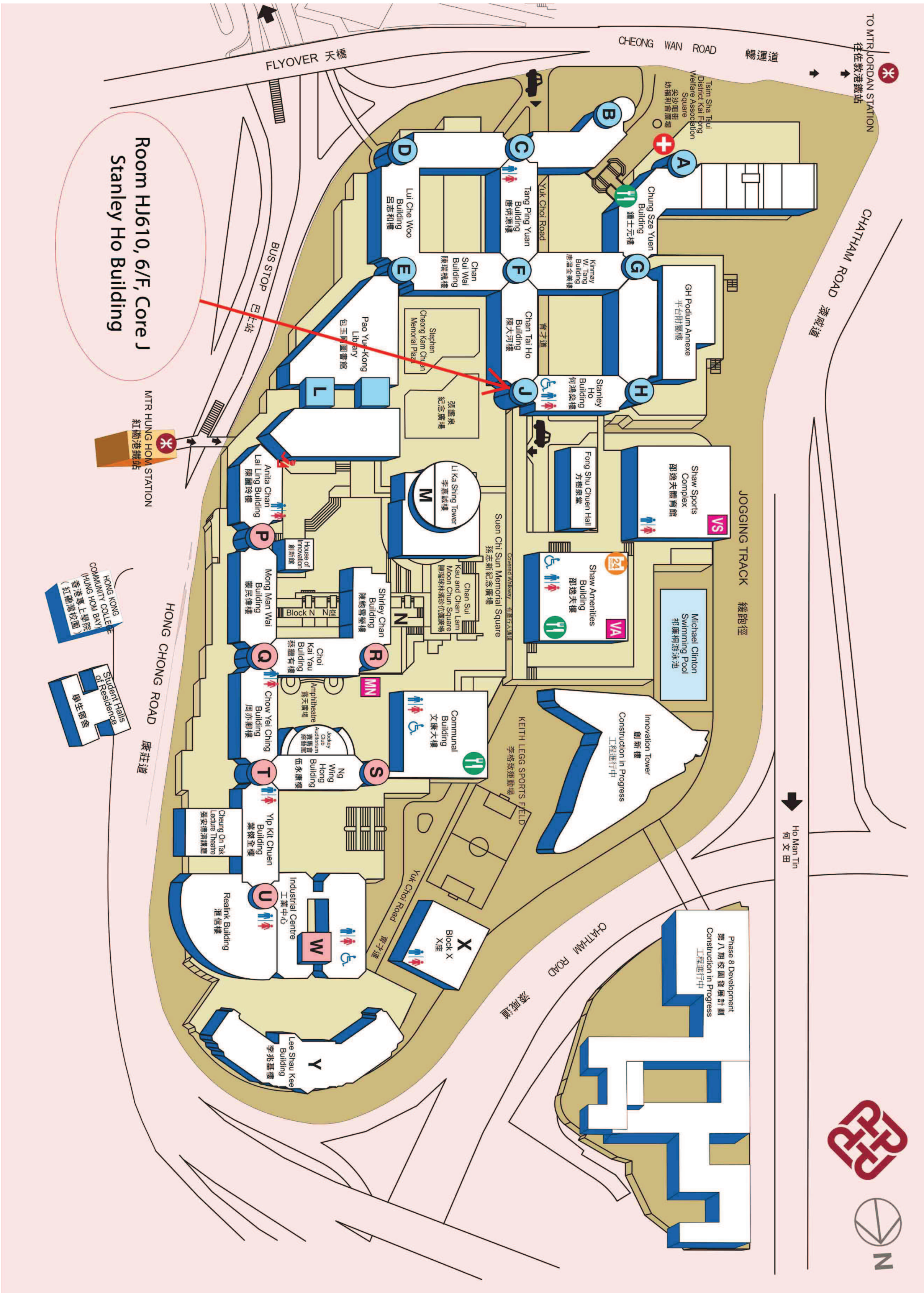
Campus Map



Room HJ610, 6/F, Core J
Stanley Ho Building
CHEONG WAN ROAD 暢運道
FLYOVER 天橋
TO MTR JORDAN STATION 往佐敦港鐵站
CHATHAM ROAD 漆咸道
BUS STOP 巴士站
MTR HUNG HOM STATION 紅磡港鐵站
HONG CHONG ROAD 康莊道
JOGGING TRACK 緩跑徑
KEITH LEGG SPORTS FIELD
Ho Man Tin 何文田
Yuk Choi Road
Lui Che Woo Building 呂志和樓
Tang Ping Yuan Building
Chung Sze Yuen Building 鍾士元樓
Chan Sui Wai Building
Kinmay W. Tang Building
Chan Tai Ho Building 陳大河樓
Stanley Ho Building 何鴻燊樓
GH Podium Annexe
Pao Yue-Kong Library 包玉剛圖書館
Li Ka Shing Tower 李嘉誠樓
Fong Shu Chuen Hall 方樹泉堂
Shaw Sports Complex 邵逸夫體育館
Shaw Amenities Building 邵逸夫樓
Michael Clinton Swimming Pool
Suen Chi Sun Memorial Square
Anita Chan Lai Ling Building
Mong Man Wai Building
Shirley Chan Building
Choi Kai Yau Building
Chow Yei Ching Building
Communal Building 文康大樓
Innovation Tower 創新樓
Ng Wing Hong Building
Yip Kit Chuen Building
Cheung On Tak Lecture Theatre
Realink Building
Industrial Centre 工業中心
Block X X座
Lee Shau Kee Building 李兆基樓
Phase 8 Development
Student Halls of Residence 學生宿舍

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

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

Programme

Day 1	**June 22, 2012(Friday)**
08:50-9:00	Registration
Session Chair	*Xiaoqiang Zhao*
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)

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Programme

Day 2	**June 23, 2012(Saturday)**
Session Chair	*Renjun Duan*
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_i, and connecting E_b 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

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

where $\gamma_i > -1$, δ_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 compressbile 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.