2018 NCTS Workshop on Mathematical Biology

Weakly Interaction between Traveling Waves in the Three-species Competition-diffusion Systems

Chueh-Hsin Chang (Tunghai University)
E-mail: changjuexin@thu.edu.tw

Abstract:
In this talk we consider the weakly interaction between two traveling wave solutions of the threes-species Lotka-Volterra competition-diffusion systems. Each of the two traveling wave solutions has one trivial component (called trivial waves). By the asymptotic behavior of the trivial waves and the existence results of the two-species traveling waves, we can observe the dynamics of the distance between the two trivial waves. We proved that there exists an unstable three-species traveling wave solution which is close to the two trivial waves. This is a joint work with Prof. Chiun-Chuan Chen and Prof. Shin-Ichiro Ei.

Estimations for the Action Functional for the N-body Problem

Kuo-Chang Chen (National Tsing Hua University)
E-mail: kchen@math.nthu.edu.tw

Abstract:
In this talk I will briefly introduce miscellaneous ways of estimating the action functional for the n-body problem. In particular, I will explain the usage of recursive binary decompositions.

Assessment on Early Regeneration Process in Tropical Rain Forests

Yu-Yun Chen (National Dong Hwa University)
E-mail: ychen@mail.ndhu.edu.tw

Abstract:
TBA

2018 NCTS Workshop on Mathematical Biology

Global Qualitative Analysis for Mathematical Population Models

Chuang-Hsiung Chiu (Southern Taiwan University of Science and Technology)
E-mail: chchiu@stust.edu.tw

Abstract:
In this talk, we discuss the globally asymptotic behaviors of mathematical population models, One is the three-level food chain and the other one is competing predators system. By using the Lyapunov functions, we obtain the sufficient conditions for the global stability of equilibrium which represents the extinction of top predator in three-level food chain and the surviving predator and its prey in the competing predators system. Moreover, a coupled model for three-level food chain is considered, we show that the differences of the same level population density approaches zero as t goes to infinity, provided that the coupling strength is sufficiently large.

Asymptotic Behavior of Equilibrium States of Reaction-diffusion Systems with Mass Conservation

Jann-Long Chern (National Central University)
E-mail: chern@math.ncu.edu.tw

Abstract:
We deal with a stationary problem of a reaction-diffusion system with a conservation law under the Neumann boundary condition. It is shown that the stationary problem turns to be the Euler-Lagrange equation of an energy functional with a mass constraint. When the domain is the finite interval $(0, 1)$, we investigate the asymptotic profile of a strictly monotone minimizer of the energy as d, the ratio of the diffusion coefficient of the system, tends to zero. In view of a logarithmic function in the leading term of the potential, we get to a scaling parameter κ satisfying the relation $\epsilon := \sqrt{d} = \sqrt{\log \kappa}/\kappa^2$. The main result shows that a sequence of minimizers converges to a Dirac mass multiplied by the total mass and that by a scaling with κ the asymptotic profile exhibits a parabola in the nonvanishing region. We also prove the existence of an unstable monotone solution when the mass is small.

Logarithmic Shifting in Spreading Governed by the Fisher-KPP Porous Medium Equation

Yihong Du (University of New England)
E-mail: ydu@une.edu.au

Abstract:
In this talk I will describe some recent results on the spreading modelled by Fisher-KPP type porous medium equations,and demonstrate that the propogation determined by these equations can be roughly described by the corresponding traveling wave with minimal speed,but with a logarithmic delay. The talk is based on joint work with Fernando Quiros (Madrid) and Maolin Zhou (Armidale).

2018 NCTS Workshop on Mathematical Biology

Accelerating Propagation in a Nonlocal Population Model with Time Delay

Jian Fang (Harbin Institute of Technology)
E-mail: jfang@hit.edu.cn

Abstract:
Time delay may slow down the propagation speed and nonlocal dispersal with fat-tailed kernel may accelerate propagation. In this talk, we discuss their joint influence in a populationmodel. It turns out that time delay can slow down the acceleration but cannot eliminate it.

Some Dynamical Behaviors for a Singular Predator-prey Model

Jong-Shenq Guo (Tamkang University)
E-mail: jsguo@mail.tku.edu.tw

Abstract:
We study the asymptotic behaviors and quenching of the solutions for a two-component system of reaction-diffusion equations modeling prey-predator interactions in an insular environment. First, we give a global existence result for the solutions to the corresponding shadow system. Then, by constructing some suitable Lyapunov functionals, we characterize the asymptotic behaviors of global solutions to the shadow system. Also, we give a finite time quenching result for the shadow system. Finally, some global existence results for the original reaction-diffusion system are given.

Spatial Heterogeneity and Time Periodicity in Lotka-Volterra Competition-Diffusion Systems

Xiaoqing He (East China Normal Unveristy)
E-mail: xqhe@cpde.ecnu.edu.cn

Abstract:
In this talk I shall report some of the recent progress on the 2 by 2 Lotka-Volterracompetition-diffusion systems when spatial heterogeneity and/or temporal periodicity are present. This is a joint work with Dr. Xueli Bai and Prof. Wei-Ming Ni.

2018 NCTS Workshop on Mathematical Biology

Global Weak Solution to the Euler-Poisson Equations with Self-gravitational Force in Spherically Symmetric Space-times

Meng Kai Hong (National Central Unversity)
E-mail: jhong@math.ncu.edu.tw

Abstract:
In this talk, we consider the Euler-Poisson equations with self-gravitational force in spherically symmetric space-times , which is governed by a mixed type 3 by 3 system of partial differential equations. The initial-boundary value problem is studied for the motion of gasous stars in astrophysics. In this talk, the mixed type 3 by 3 Euler-Poisson system is re-formulated as a 3 by 3 hyperbolic resonant system in transom flows. The global existence of weak solutions is established by a generalized version of Glimm scheme. Numerical simulations are also provided. This is the joint work with Shih-Wei Chou (NCU) and Chia-Chieh Chu (NTHU).

Mathematical Modeling of Infectious Diseases: Life is a Circle

Ying-Hen Hsieh (China Medical University)
E-mail: hsieh@mail.cmu.edu.tw

Abstract:
I will give an overview of my work on mathematical modeling of various emerging infectious diseases over nearly three decades (including modeling of the 2003 SARS outbreak with Sze-Bi Hsu), starting from HIV modeling of commercial sex in Thailand in 1990s to the more recently HIV modeling of FSW/IDU groups in southwest China.

TBA

Tzy-Wei Hwang (National Chung Cheng University)
E-mail: twhwang@math.ccu.edu.tw

Abstract:
TBA

2018 NCTS Workshop on Mathematical Biology

Population Persistence in a Benthic-drift River Environment

Yu Jin (University of Nebraska-Lincoln)
E-mail: yjin6@unl.edu

Abstract:
We consider a river environment where species grow on the benthos, drift in the water column and transfer between the water column and the benthos. We use reaction-diffusion-advection equations coupled with ordinary differential equations to describe the dynamics of a single species and of two competitive species. We study the population persistence criteria, based on persistence measures, including the net reproductive rate and eigenvalues of corresponding eigenvalue problems. We then use these measures to numerically investigate the influences of factors, such as the birth rate, various flow regimes, diffusion rates, competition rates, transfer rates, and spatial heterogeneity on population persistence. The theory developed here provides the basis for effective decision-making tools for water managers.

Uniform Persistence and Global Stabilty of a Well-Mixed Multiplex Epidemic Model with Distributed Time Delay

Jonq Juang (National Chiao Tung University)
E-mail: jjuang@math.nctu.edu.tw

Abstract:
The description and mathematical results of an epidemic model in a well-mixed multiplex network with distributed time delay are to be given.

Oscillatory Dynamics of an Intravenous Glucose Tolerance Test Model with Delay Interval

Yang Kuang (Arizona State University)
E-mail: kuang@asu.edu

Abstract:
Delay differential equations have been frequently used to study complex dynamics observed in nature. More recently, they are used to understand intriguing physiological phenomena such as those expressed by glucose and insulin interaction. We propose a simple set of delay differential equations to model an intravenous glucose tolerance test. This model uses two parameters to simulate not only both discrete time delay and distributed time delay in the past interval, but also the time delay distributed in a past sub-interval. We show that this relatively simple model provides good fit to fluctuating patient data sets and reveals some intriguing dynamics. Most importantly, our model may remove the defect in the well known Minimal Model which often overestimates the glucose effectiveness index.

2018 NCTS Workshop on Mathematical Biology

Dispersion Relations of Periodic Quantum Graphs Associated with Archimedean Tiling

Chun-Kong Law (National Sun Yat-sen University)
E-mail: law@math.nsysu.edu.tw

Abstract:
We study the periodic spectrum of some differential operators, in particular the Schrödinger operator acting on infinite polygonal graphs. Using Floquet-Bloch theory, we derive and analyze on the dispersion relations of the periodic quantum graph generated by triangles and rectangles. The analytic variety, also called Bloch variety, gives the spectrum of the differential operators. Furthermore, it is well known that there are 11 types of Archimedean tilings in the plane. We take several of them. Through a systematical characteristic function method, we are able to derive the dispersion relation on the graphs formed by these tilings. We shall perform further analysis on these simple dispersion relations.

An Introduction to the Overdetermined Problem of Singularly Perturbed Model

Chiun-Chang Lee (National Tsing Hua University)
E-mail: chlee@mail.nd.nthu.edu.tw

Abstract:
This talk briefly introduces a singularly perturbed Dirichlet problem in bounded domains, overdetermined with a Neumann boundary condition on the boundary. The inspiration of studying this problem comes from Serrin's work on torsion problem (ARMA 43 (1971), 304-318) and Shibata's work on a singularly perturbed semilinear elliptic equation (TAMS 356 (2004), 2123-2135).

Global Dynamics of an In-host HIV Model with Nonlocal State Structures

Michael Li (Shanxi University & University of Alberta)
Email: myli@ualberta.ca

Abstract:
We consider an in-host model for HIV infection of CD4+ T cells. A continuous state variable x is introduced to represent the level of viral productivity of an infected T cell. When $x = 0$, the infected cell is in its latent state, unseen to the bodys immune systems and not targeted by antiviral drugs. For $x \neq 0$, the T cell is productively infected and the level of HIV replication inside the cell is measured by x, e.g. in terms of the level of viral RNA. Antigenic stimulations can cause an latently infected cells to become productive, and antiviral actions of the immune system and antiviral drugs can cause nonlocal changes in the state variable x. The resulting model is a system of differential-integral equations with a nonlocal term. We investigate the semigroup generated by the model, its dissipasivity and the existence of the global attractor in a Banach space. We further derived the basic reproduction number R_0 for the viral infection and show that it is a sharp threshold for the local stability of the infection-free equilibrium. For $R_0 > 1$, we show that the system is uniformly persistent and a unique positive steady-state is globally asymptotically stable. This is a joint work with Drs. Zhipeng Qiu and Zhongwei Shen.

2018 NCTS Workshop on Mathematical Biology

Spreading Speeds of Nonlocal KPP Equations via Generalized Principal Eigenvalues and Homogenization

Xing Liang (Univ. Sci. Tech. China)
E-mail: xliang@ustc.edu.cn

Abstract:
In this talk I will introduce some new work of ours about the spreading speeds of nonlocal KPP equations in heterogeneous media. We develop the theory of generalized principal eigenvalues and the approach of homogenization for nonlocal diffusion equations to deal this problem. We prove the spatially almost periodic structure and the weakly irreducible diffusion can guarantee the existence of a uniform spreading speed.

Asymptotic Behavior of Principal Eigenvalue for 2nd Order Elliptic Operators

Yuan Lou (Ohio State University)
E-mail: lou@math.ohio-state.edu

Abstract:
We will consider the effects of diffusion and advection on principal eigenvalue of elliptic operators. Various asymptotic behaviors of the principal eigenvalue, as diffusion or advection coefficients approach zero or infinity, are discussed. Motivations of these studies come from the speedup of front propagation, the invasion and competition of populations.

Modeling the Population Dynamics for Stage-structured Species

Yijun Lou (The Hong Kong Polytechnic University)
E-mail: Yijun.lou@polyu.edu.hk

Abstract:
This talk presents my recent studies with collaborators on the population dynamics of stage-structured species growth. Based on a hyperbolic partial differential equation, systems of ordinary differential equations with/without delays will be presented to address the following aspects in population growth: (a) population growth with many stages; (b) intra- and inter-specific competition within age classes; (c) continuous seasonal effects; (d) diapause; and (e) climate change.

2018 NCTS Workshop on Mathematical Biology

From Mathematical Biology, Dynamical System to Mathematical Analysis

Ting-Kung Luo (Providence University)
E-mail: tkluo@pu.edu.tw

Abstract:
1. Some differential equation from Chemostitive and Biology.
2. The mathematical analysis in dynamical system.
3. The simulation about the differential equation.
4. Conclusion.

Singular Perturbations in Structured Population Dynamics

Pierre Magal (University of Bordeaux)
E-mail: pierre.magal@u-bordeaux.fr

Abstract:
In this presentation we will consider some age structured population dynamics models. An example age structured model with two time scales is provided by hospital-acquired infections. Then we will turn to the abstract Cauchy problem reformulation and integrated semigroups. Then we will present some recent results related to the persistence of invariant manifolds and their stability.

Spreading Waves in a Farmer and Hunter-gatherer Model in the Neolithic Transition in Europe

Masayasu Mimura (Musashino University & Meiji University)
E-mail: mimura.masayasu@gmail.com

Abstract:
The Neolithic transition began the spread of early agriculture throughout Europe through interactions between farmers and hunter-gatherers about 10,000 years ago. Archeological evidence produced by radiocarbon dating indicates that the expanding velocity of farming is roughly constant all over Europe. Theoretical understanding of such evidence has been performed from mathematical modeling viewpoint. We propose a farmer and hunter-gatherer model from the viewpoint of the influence of farming technology. In this talk, we mainly focus on the ecological relation between spreading waves of farmers and hunter-gatherers and farming technology effect. This study has been working with Prof. J.-C. Tsai (National Tsing Hua Univ.) and Dr. M. H. Kabir(Jahangirmagar Univ., Bangladesh).

2018 NCTS Workshop on Mathematical Biology

Dynamics of a Consumer-resource Reaction-diffusion Model: Homogeneous vs. Heterogenous Environments

Wei-Ming Ni (University of Minnesota)
E-mail: weiming.ni@gmail.com

Abstract:
We study the dynamics of a consumer-resource reaction-diffusion model, in both homogeneous and heterogeneous environments. For homogeneous environments, we establish the global stability of constant steady states. For heterogenous environments we study the existence, uniqueness and stability of positive steady states and the persistence of time-dependent solutions. A comparison of homogeneous vs heterogeneous environments will be included.

Modeling the Transmission Dynamics of Avian Influenza H7N9 Virus in China

Shigui Ruan (University of Miami)
Email: ruan@math.miami.edu

Abstract:
In March 2013, a novel avian-origin influenza A (H7N9) virus was identified among human patients in China and a total of 124 human cases with 24 related deaths were confirmed by May 2013. There were no reported cases in the summer and fall 2013. However, the virus has been coming back in November every year. In fact, the second outbreak from November 2013 to May 2014 caused 130 human cases with 35 deaths, the third outbreak from November 2014 to June 2015 caused 216 confirmed human cases with 99 deaths, the fourth outbreak from November 2015 to July 2016 caused 114 confirmed human cases and 45 deaths, respectively. The current outbreak starting from November 2016 has caused hundreds of cases and deaths. In this talk, I will introduce some recent studies on modeling the transmission dynamics of the avian influenza A (H7N9) virus from birds to humans and apply our models to simulate the open data for numbers of the infected human cases and related deaths reported by the Chinese Center for Disease Control and Prevention. The basic reproduction number is estimated and sensitivity analysis of in terms of model parameters is performed. Our studies demonstrate that H7N9 virus has been well established in birds and will cause regular outbreaks in humans again in the future.

Modeling Animal Movement with Memory with Partial Differential Equations with Time-delay

Junping Shi (College of William and Mary)
Email: jxshix@wm.edu

Abstract:
Animal populations often self-organize into territorial structure from movements and interactions of individual animals. Memory is one of cognitive processes that may affect the movement and navigation of the animals. We will review several mathematical approaches of animal spatial movements, and also introduce our recent work using partial differential equations with time-delay to model and simulate the memory-based movement. We will show the bifurcation and pattern formation for such models. It is based on joint work with Chuncheng Wang, Hao Wang, Xiangping Yan, Qingyan Shi and Yongli Song.

2018 NCTS Workshop on Mathematical Biology

Text Mining: Application in Readers Clustering

Hui-Chun Tien (Providence University)
E-mail: hctien@gm.pu.edu.tw

Abstract:

TBA

Synchronization in Coupled Systems

Jui-Pin Tseng (National Chengchi University)
E-mail: jptseng@nccu.edu.tw

Abstract:

This talk presents a framework to investigate the approximate synchronization of coupled systems. The framework accommodates a large class of coupled systems and network systems under general coupling. The units which constitute the coupled systems can be identical or non-identical. The non-identical ones include possible cases of slightly different units, units with parameter mismatch, or completely disparate units. Communication delay was also considered into the framework. The applications of the present theory to coupled FitzHugh-Nagumo neurons are illustrated. We also extend the analysis to study the asymptotic synchronization of coupled Lorenz systems.

Some Interesting Results on Evolution of Bifurcation Curves for a One-dimensional Dirichlet-Neumann Problem with Cubic Nonlinearity

Shin-Hwa Wang (National Tsing Hua University)
E-mail: shwang@math.nthu.edu.tw

Abstract:

We study the evolution of bifurcation curves of positive solutions for the one-dimensional Dirichlet-Neumann problem

$$\begin{cases} u''(x) + \lambda(-\varepsilon u^3 + u^2 + u + 1) = 0, \ 0 < x < 1, \\ u(0) = 0, \quad u'(1) = -c < 0, \end{cases}$$

where $\lambda > 0$, $\varepsilon > 0$, and $c > 0$. We prove that, for $\varepsilon \geq \varepsilon^*$ $(= 2.37)$ and $c > 0$, the bifurcation curve is strictly increasing on the $(\lambda, \|u\|_\infty)$-plane. While, for $1/10 \leq \varepsilon \leq 1/5$, there exist a positive number ε_* (≈ 0.178) and three nonnegative functions $c_0(\varepsilon) < c_1(\varepsilon) < c_2(\varepsilon)$ defined on $[1/10, 1/5]$ with $c_0(\varepsilon) = 0$ if $1/10 \leq \varepsilon \leq \varepsilon_*$ and $c_0(\varepsilon) > 0$ if $\varepsilon_* < \varepsilon \leq 1/5$, such that, on the $(\lambda, \|u\|_\infty)$-plane, (i) when $0 < c < c_0$ and $c \geq c_2$, the bifurcation curve is strictly increasing; (ii) when $c = c_0$, the bifurcation curve is monotonically increasing; (iii) when $c_0 < c < c_1$, the bifurcation curve is S-shaped; (iv) when $c_1 \leq c < c_2$, the bifurcation curve is $\subset$-shaped.

2018 NCTS Workshop on Mathematical Biology

Invariant Cone Families in Infinite-dimensional Dynamical Systems

Yi Wang (University of Science and Technology of China)
E-mail: wangyi@ustc.edu.cn

Abstract:
In this talk, we will report some recent progress on the invariant cone families (ICF) in infinite-dimensional dynamical systems. For linear cocycles, we will discuss the close relation of the ICF with Multiplicative Ergodic Theorem, Dominated Splitting (Exponential Separation), as well as Krein-Rutman Type Theorem. For nonlinear cocycles, we show that ICF plays a key role in investigating the dynamics of nonautonomous parabolic equations. In particular, we show the appearance of almost periodically (autmorphically) forced circle for infinite-dimensional systems generated by nonlinear scalar parabolic equations.

Traveling Wave Solution of a Class of Delay Predator-Prey Models

Ting-Hui Yang (Tamkang University)
E-mail: thyang@mail.tku.edu.tw

Abstract:
It is well known that global dynamics of a two-species non-diffusive model can be clarified completely for most functional responses. However, an ecological non-diffusive model with at least three species or with delay could have very complex dynamics. Moreover, the traveling wave solution connecting two equilibria of a diffusive system can describe the state transition between two spatial homogeneous steady states. Hence a novel concept, weak traveling wave solutions or semi-traveling wave solutions, was proposed by Huang [2016 JDE], Zhang et. al [2016 JDE] and Zhang [2017 JDE]. A solution with moving coordinates is called a semi-traveling wave solution connected to the unstable equilibrium if the solution is a strictly positive entire function with the unstable equilibrium as its negative asymptotically limit. In this work, we consider a class of delay predator-prey type diffusion-reaction systems. The existence and non-exsitence of weak traveling wave solution of a class of delay predator-prey type diffusion-reaction systems were showed by upper-lower solution scheme. Moreover, the strictly positivity of such solutions were established by Hale's persistence theory for delay differential equations. In addition, we show the existence and stability of positive equilibrium for the non-diffusive case under some sufficient conditions. Finally, without delay, the existence of traveling wave solution from the unstable boundary equilibrium to the stable positive equilibrium were showed by constructing another pair of upper-lower solutions.

A Periodic Disease Transmission Model with Asymptomatic Carriage and Latency Periods

Yuan Yuan (Memorial University of Newfoundland)
E-mail: yyuan@mun.ca

Abstract:
In this talk, the global dynamics of a periodic disease transmission model with two delays in incubation and asymptomatic carriage periods is investigated.We first derive the model system with a general nonlinear incidence rate function by stage-structure. Then, we identify the basic reproduction ratio $\mathcal{R}_0$ for the model and present numerical algorithm to calculate it. We obtain the global attractivity of the disease-free state when $\mathcal{R}_0 < 1$ and discuss the disease persistence when $\mathcal{R}_0 > 1$. We also explore the coexistence of endemic state in the non-autonomous system and prove the uniqueness with constants coefficients. Numerical simulations are provided to present a case study regarding the meningococcal meningitis disease transmission and discuss the influence of carriers on $\mathcal{R}_0$.

2018 NCTS Workshop on Mathematical Biology

Spatial Dynamics of a Nonlocal Dispersal Population Model in a Shifting Environment

Xiaoqiang Zhao (Memorial University of Newfoundland)
E-mail: zhao@mun.ca

Abstract:
We consider the spatial dynamics of a nonlocal dispersal population model in a shifting environment where the favorable region is shrinking. It is shown that there exists a critical number c^* such that the species becomes extinct in the habitat if the speed of the shifting habitat edge is greater than c^*, while the species persists and spreads along the shifting habitat if this speed is less than c^*. Further, we establish the existence, uniqueness and global exponential stability of the forced traveling wave with the wave speed at which the habitat is shifting.

Even vs Concentrative Allocation of Time between Patches for Predators

Xingfu Zou (University of Western Ontario)
E-mail: xzou@uwo.ca

Abstract:
For a predator that can choose to disperse between patches, how should it allocate its time between patches? We propose and analyze a mathematical model in the form of ordinary differential equations to explore how the local population dynamics of the prey and the time allocation of the predator interact to affect the long term outcome. This is a joint work with Chang-Yuan Cheng