加拿大纽芬兰纪念大学袁沅教授报告摘要

1. Stability and Bifurcation in FDE with Distributed Delay

In some applications of delay differential equations in population dynamics, the need of incorporation of distributed delay is often the result of the existence of some processes or structures. The main objective of the talk is to provide some information of the stability (including local and global stability) and Hopf bifurcation analysis in a general functional differential equation with distributed delay. The local stability parameter regions related to time delay are given and compared for a general distribution delay function and three frequently used distributed delays including Dirac, uniform and Gamma distributions. A set of sufficient conditions for the global stability of the positive equilibrium is established for a large class of non-monotone time-delayed differential equations by the method of fluctuations and the exponential ordering approach. With the loss of the stability at the boundary of these regions, we discuss the Hopf bifurcation using normal form method, there the computation of the coefficients are given in the form of the corresponding characteristic equation explicitly. Using the theoretical results we study two examples about white blood cell models and address the effect of the distributed time delay in the physiological oscillations. Numerical simulation are illustrated to verify the theoretical predictions.

2. A Periodic Disease Transmission Model with Asymptomatic Carriage and Latency Periods

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 nonautonomous 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 $\mathcal{R}_0$.

3. A Stage-structured Model for Fish Stock with Harvesting

We propose a mathematical model for a single species fish stock with three stages structure: juveniles, small adults and large adults with two harvesting strategies for mature classes, maturity and size selectivities. The purpose of the work is to investigate the dynamical behavior of the model and discuss the effect of harvesting. We identify the adult reproduction number $\mathcal{R}_A$ for the model; obtain

the local and global stability of the trivial equilibrium when $\mathcal{R}_A<1$; discuss the population persistence and existence of a unique positive equilibrium when $\mathcal{R}_A>1$. Numerical simulations are provided to investigate the influence of harvesting functions, discuss the optimal harvesting rates and explore the effect of periodic coefficients on the dynamical system.

4.Nonlinear Dynamics in Modeling Sea Lice with Stage Structure

Sea lice infection is one of the major threats in the marine fishery, especially for farmed salmon. In this work, we propose two mathematical models, one is for the growth of sea lice with a three-stage structure: non-infectious immature, infectious immature and adults where the level of non-infectious immature development depends on the size of the adult population; another is for the control of sea lice with the predator-prey interaction between cleaner fish and sea lice. By using mathematical techniques and an appropriate change of variables, we first describe the nonlinear dynamics by a system of partial differential equations, then transform it into a system of delay differential equations with constant delay. We provide two important indexes: the adult reproduction number $\mathcal{R}_s$ for sea lice and the net reproductive number of cleaner fish $\mathcal{R}_f$, address the global dynamics relating to $\mathcal{R}_s$ and $\mathcal{R}_f$ theoretically, including the global/local stability of the equilibria, uniformly persistence and possible Hopf bifurcation. Numerical simulations are provided to confirm the theoretical results.

5. Dynamics in Internet Congestion Control Models

We consider two Internet congestion control systems which are presented as a group of differential equations with time delay, modeling the random early detection (RED) algorithm and implement the TCP/RED algorithm by a new frame of dynamic routing, based on the measurement of occupation ratio of router buffer for different links, which only requires the information of the queue size at the buffer of the router, to stabilize the system. For the simple network topology, we show that the Filippov solution exists under some restrictions on parameters. For the case with a single user group and two alternative links, we prove that the discontinuous boundary, or equivalently the sliding region, always exists and is locally attractive. We also classify several types of equilibrium in the designed dynamic routing and employ the numerical method to study the stability of the steady state.