PhD Thesis Seminar Series
Department of Mathematics and Statistics
Memorial University of Newfoundland
St. John's, Canada

Global dynamics of periodic infectious disease models with time-dependent delays

by

Fuxiang Li
PhD (Mathematics) Candidate

Dr. Xiaoqiang Zhao
Supervisor

14.00-15.00, Friday 7 February, 2020: HH 3017

Abstract

Many infectious diseases have seasonal trends and exhibit variable periods of peak seasonality. Understanding the population dynamics due to seasonal changes becomes very important for predicting and controlling disease transmission risks. For some directly transmitted and vector-borne diseases, the length of the incubation period strongly depends on the temperature. In this talk, I will present the study of the global dynamics of some periodic epidemic models with periodic incubation periods. We start with a classical SEIRS epidemic model with a time-dependent latent period. Moreover, vector-borne diseases, such as West Nile virus, bluetongue, and malaria, are always highly dependent on seasonal change, especially the temperature. To investigate the seasonal effects and temperature-dependent delays on West Nile virus, we present a periodic functional differential equations model with the vertical transmission, the periodic maturation delay, and the periodic extrinsic incubation period. In addition, we propose a bluetongue model with seasonality and temperature-dependent incubation period, which describes the dynamics of bluetongue transmission via cattle and sheep as hosts and midges as vectors. To explore the effects of the spatial and temporal heterogeneity in hosts and vectors, and only vector movements on the spread of bluetongue, we develop a nonlocal periodic reaction-diffusion model of bluetongue disease with periodic time delays. Based on the theory of the basic reproduction ratio, we derive and numerically compute the basic reproduction ratio for our model systems, and establish a threshold-type result for the global dynamics in terms of the basic reproduction ratio for each model system. Numerical simulations or case studies are carried out to illustrate the analytic results and help us provide some new findings.