PIMS / AMI Seminar

Tuesday, November 26, 2019
3:30 p.m.
CAB 657

"Laplacian-Coupled Complex Systems on Varying Networks with Applications to Spatial Population Dynamics"

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Abstract

Large-scale complex systems in science and engineering can often be regarded as coupled systems of small-scale differential equations on networks. A network can be mathematically treated as a weighted, directed graph. Specifically, within-vertex dynamics can be described by a small-scale system of differential equations, and directed arcs of the network represent the coupling among vertex systems. In metapopulation dynamics, the coupling can be depicted as Laplacian of movement network. Algebraic and combinatorial theories of Laplacian provide new and effective approaches to investigate spatial population dynamics, resolving some open problems in the literature.

In a recent collaboration with Shanshan Chen, Junping Shi and Yixiang Wu, we establish a new result on spectral mononoticity of Laplacian-perturbed matrices using two approaches: a graph-theoretic approach based on Kirchhoff's Matrix-Tree Theorem and a constructive approach employing Collatz-Wielandt formula. Specifically, for a square matrix Q-dL, where Q is a diagonal matrix encoding within-vertex (within-patch) population dynamics and L is a Laplacian matrix describing population dispersal among patches in a heterogeneous environment, the monotonicity of its spectral bound with respect to dispersal speed d is established. This result has been applied to various ecological and epidemiological models to establish the dichotomy of population persistence and extinction, and prove the monotonicity of threshold values with respect to dispersal speed.