William Benter Distinguished Lecture Series

A Series of Distinguished Lectures in Pure and Applied Mathematics
organized by
Liu Bie Ju Centre for Mathematical Sciences
City University of Hong Kong

Mathematical Analysis of a PDE System for Biological Network Formation

by

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Abstract

Motivated by recent physics papers describing basis principles for biological network formation, we study an elliptic-parabolic system of partial differential equations proposed by D. Hu and D. Cai in 2012. The model describes the pressure field by a Darcy's type equation and the dynamics of the network conductance under pressure force effects with diffusion representing randomness in the material structure. We prove the existence of global weak solutions and of local mild solutions and study their long time behavior.

It turns out that, by energy dissipation, steady states play a central role in understanding the pattern capacity of the system. We show that for a large diffusion coefficient, the zero steady stateis stable. Patterns occur for small values of the diffusion coefficient because the zero steady state is Turing unstable in this range; for vanishing diffusion we can exhibit a large class of dynamically stable (in the linearized sense) steady states.

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