Temple University Mathematics Colloquium

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will speak on

Chemotaxis and numerical methods for chemotaxis models

ABSTRACT: In this talk, I will first discuss several chemotaxis models including the classical Keller–Segel model. Chemotaxis is the phenomenon in which cells, bacteria, and other single-cell or multicellular organisms direct their movements according to certain chemicals (chemoattractants) in their environment. The mathematical models of chemotaxis are usually described by highly nonlinear time dependent systems of PDEs. Therefore, accurate and efficient numerical methods are very important for the validation and analysis of these systems. Furthermore, a common property of all existing chemotaxis systems is their ability to model a concentration phenomenon that mathematically results in solutions rapidly growing in small neighborhoods of concentration points/curves. The solutions may blow up or may exhibit a very singular, spiky behavior. In either case, capturing such solutions numerically is a challenging problem. In our work we propose a family of stable (even at times near blow up) and highly accurate numerical methods, based on interior penalty discontinuous Galerkin schemes (IPDG) for the Keller–Segel chemotaxis model with parabolic–parabolic coupling. This model is the basic step in the modeling of many real biological processes and it is described by a system of a convection-diffusion equation for the cell density, coupled with a reaction-diffusion equation for the chemoattractant concentration. We prove theoretical hp error estimates for the proposed discontinuous Galerkin schemes. Our proof is valid for pre-blow-up times since we assume some regularity of the exact solution. Numerical experiments to demonstrate the stability and high accuracy of the proposed methods for chemotaxis models and comparison with other methods will be presented. Ongoing research projects will be discussed as well.

Friday, 29 January 2010
Lecture at 11:00 am
Coffee, tea, and refreshments from 10:30 am
Room 617, Wachman Building
Department of Mathematics