ABSTRACT

Effect of rough boundaries and internal noise in reaction-diffusion equations

Chiara Mocenni, PhD.
Dipartimento di Ingegneria dell'Informazione e Scienze Matematiche
University of Siena

The work addresses the problem of analyzing the spatio-temporal dynamics of reaction-diffusion partial differential equations associated to distributed systems that possess rough boundaries and are endowed with Neumann or Dirichlet boundary conditions. Using techniques from homogenization theory and multiple-scale analysis we derive the effective equations and boundary conditions that are satisfied by the homogenized solution. We present numerical simulations that validate our theoretical results and compare it with the alternative approach based on solving the same equation with a smoothed version of the boundary. The homogenized solution is shown undergoing dynamical regime shifts, such as anticipation of pattern formation, obtained by varying the diffusion coefficient. The problem of stochasticity induced oscillations in reaction-diffusion systems showing Turing bifurcations is also investigated by simulating the chemical master equation associated to the reaction-diffusion equation. The results obtained by applying an inhomogeneous stochastic simulation algorithm, confirm the conjecture that internal noise can induce and stabilize spatial patterns in oscillating nonlinear distributed systems.