

Seminar of the Work Group
Nonlinear Partial Differential Equations
SS 26

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Seminar room: SR 3.069

Nonlinear Stability Analysis and Pattern Formation in Reaction-diffusion-ODE Systems

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Abstract

Reaction-diffusion-ODE systems have emerged as powerful models for biological pattern formation. They couple diffusive and non-diffusive nonlinear processes and exhibit a rich variety of spatial structures, including classical Turing patterns as well as far-from-equilibrium patterns with singularities and jump discontinuities. This singular behavior distinguishes reaction-diffusion-ODE systems from classical reaction-diffusion systems and substantially complicates the analysis of nonlinear stability. In this talk, we develop a general framework for the analysis of bounded stationary solutions, establishing conditions for nonlinear stability and instability. As an application, we derive conditions for diffusion-driven instability (DDI), a key mechanism underlying pattern formation in these systems. While previous studies have primarily focused on DDI induced by instability of the purely non-diffusive subsystem, we show that DDI can also arise from coupling between non-diffusive and slowly diffusing components, leading to dynamics involving three distinct spatial scales.