Numerical methods for spatio-temporal oscillating solutions in reaction-diffusion models

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Abstract

This talk concerns numerical approximations of oscillating patterns in reaction-diffusion systems. Stability analysis on a test reaction-diffusion system with oscillating solution allows comparisons in terms of stability regions and stepsize restrictions of some time integrators. Moreover, a dissipation and dispersion analysis are also carried out, see [1]. We consider the well known and commonly used IMEX Euler method, the explicit and semi-implicit ADI methods and two new methods, symplectic in absence of diffusion, named IMSP and IMSP_IE. For the discretization in the space Extended Central Difference Formulas (ECDFs) of order p=2,4,6 (ECDF_p) are applied.

The theoretical results are supported by numerical experiments. Firstly we consider the space dependent Lotka-Volterra model, with spatially homogeneous solution oscillating only in time, then we solve the Schnackenberg model, prototype of reaction-diffusion system with Turing-Hopf patterns oscillating both in space and time. Moreover, we present numerical simulations of Turing-Hopf patterns for the morphochemical model for metal growth described in[3]. We point out that both IMSP and IMSP_IE methods are more efficient for the Lotka-Volterra model in presence of diffusion. Nevertheless, in the case of Turing patterns oscillating in space and time, the explicit ADI method reaches good accuracy with lower computational cost.

References

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