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On pattern formation in reaction-diffusion systems containing self- and cross-diffusion.
(English) Zbl 07443093
Commun. Nonlinear Sci. Numer. Simul. 105, Article ID 106090, 12 p. (2022)

Summary: In this article we propose a unified framework in order to study reaction-diffusion systems containing self- and cross-diffusion using a free energy approach. This framework naturally leads to the formulation of an energy law, and to a numerical method respecting a discrete version of the latter. It constitutes an alternative method and complements the standard linear stability analysis, as it allows for the numerical study of nonlinear patterns, while monitoring the energy evolution, even in complex geometries. As an application, we propose and study a modified Gray-Scott system augmented with self- and cross-diffusion terms. Numerical simulations unveil original patterns, clearly distinct from those obtained with linear diffusion only.

MSC:
65-XX Numerical analysis
35-XX Partial differential equations

Keywords:
reaction-diffusion; self-diffusion; cross-diffusion; Gray-Scott; energy law; finite-element method; Turing pattern; traveling wave; complex geometry

Full Text: DOI