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Delayed pattern formation in two dimensional domains

Nirmali Prabha Das

Bolyai Institute, University of Szeged, Hungary
das.nirmali5@gmail.com

Our study focuses on the complex interactions between gene expression time delay and domain size in a reaction-diffusion system, which play crucial roles in the development of intricate patterns over time. To investigate these phenomena, we utilize an advanced version of the Schnakenberg model called the LI (ligand internalisation) model. On a one-dimensional domain, a linear relationship has been observed between the gene expression time delay and the time it takes for patterns to form. We extend the model to the two dimensional domain, and confirm that similar relationship holds there as well. However, our exploration reveals a non-monotonic correlation between domain size and the time required for pattern emergence, and identifies critical domain sizes that optimize the efficiency of pattern formation. In our attempt to unravel this complex dynamics, we expand our analysis by considering a diverse range of initial conditions, including random perturbations of the spatially homogenous steady state as well as initial functions from its unstable manifold, to observe how pattern formation unfolds. Finally, we compute a two-parameter chart of patterns, with respect to time delay and domain size.

Joint work with Bornali Das, István Balázs, and Gergely Röst.