Spatio-Temporal Patterns in Stochastic Reaction-Diffusion Systems

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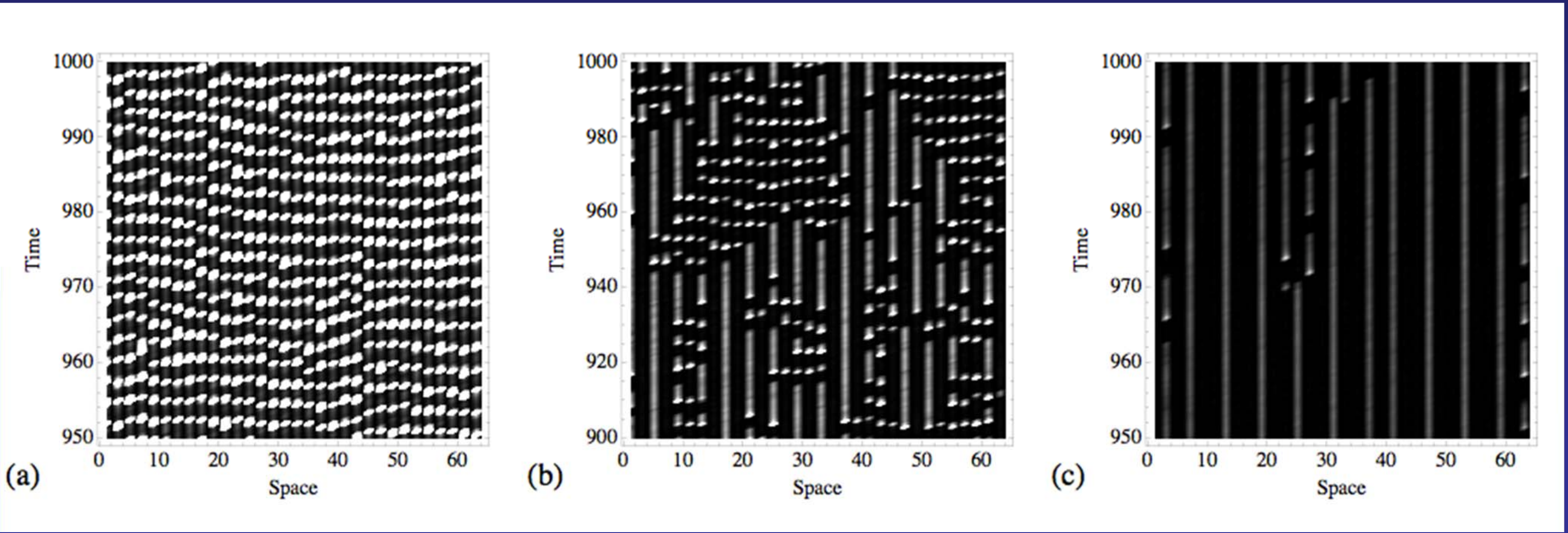
Intrinsic or demographic noise has been shown to play an important role in the dynamics of a variety of systems including biochemical reactions within cells, predator-prey populations, and oscillatory chemical reaction systems, and is known to give rise to oscillations and pattern formation well outside the parameter range predicted by standard mean-field analysis. Motivated by an experimental model of cells and tissues where the cells are represented by chemical reagents isolated in emulsion droplets[Soft Matter, 2011, 7, 3155], we study the stochastic Brusselator, a two species activator-inhibitor chemical reaction model. Using a combination of computer simulations and analytical techniques we aim understand how complex spatio-temporal patterns emerge from the simple interactions between the individual elements of the system and to help develop a general framework for studying stochastic reaction-diffusion systems.



Space time plots of the stochastic Brusselator simulation on a 1D heterogenous lattice. The horizontal axis represents the position on the lattice and the vertical axis represents time. In figure (a) the activator and inhibitor species diffuse on the lattice with the same rate, while in figures (b) and (c) the diffusion rate of the inhibitor is increased, leading to the emergence of stochastic Turing patterns.