Boundary Effects in Stochastic Cyclic Competition Models on a Two-Dimensional Lattice

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We study noise-induced and -stabilized spatial patterns in two distinct stochastic population model variants for cyclic competition of three species, namely the Rock-Paper-Scissors (RPS) and the May-Leonard (ML) models. In two dimensions, it is well established that the ML model can display (quasi-)stable spiral structures, in contrast to simple species clustering in the RPS system. Our ultimate goal is to impose control over such competing structures in systems where both RPS and ML reactions are implemented. To this end, we have employed Monte Carlo computer simulations to investigate how changing the microscopic rules in a subsection of a two-dimensional lattice influences the macroscopic behavior in the rest of the lattice. Specifically, we implement the ML reaction scheme on a torus, except on a ring-shaped patch, which is set to follow the cyclic Lotka-Volterra predation rules of the RPS model. There, we observe a marked disruption of the usual spiral patterns in the form of plane waves emanating from the RPS region. Using fast Fourier transforms we find that the spacial extent of these disruptions is set by the diffusion rate in the May-Leonard region. Furthermore, the overall population density drops considerably in the vicinity of the interface between both regions.

We will continue to characterize these effects before using our deepened understanding of these systems to develop possible methods for local external control. We plan to begin by exploring the possibility of using pulsed and periodic seeding to either stabilize or destroy the spiral patterns displayed by our simulations.

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