Plane-Waves at the Interface Between Two-Dimensional Rock-Paper-Scissors and May-Leonard Systems

M. Lazarus Arnau
PHYS 4316 Modern Experimental Physics

February 5, 2020

The Rock-Paper-Scissors (RPS) and May-Leonard (ML) models are two models are used to study competition and co-existance in systems which obey a cyclic (or "rock-paper-scissors") predation scheme. When implemented on a two-dimensional lattice, the RPS model exhibits clustering of species whereas the ML system, under certain parameter regimes, can produce long-lived spiral-wave formations. This difference in behavior is a result of the fact that the RPS model treats predation and reproduction as a single process, where in the ML model predation and reproduction are two seperate processes. The formation of spirals in ML systems is an example of a noise-induced nonlinear effect.

In research performed with Prof. Uwe Täuber and Shannon Serrao we used Monte-Carlo techniques to simulate a two-dimensional lattice with periodic boundary conditions which obeys the microscopic rules of the ML model everywhere except for a narrow vertical band which obeys the rules of the RPS model. We discovered that, near the interface, the spiral-waves gave way to plane-waves which travel away from the boundary in to the ML region. We also observed a marked drop in population density near the interface.

This semester we will continue our investigation of this phenomenon. We will measure to what extent the presence and strength of the plane-waves are dependent on the mobility rate in the RPS and ML regions. We hope to use this information to investigate how local periodic seeding and/or mixing can be used to disrupt the formation of otherwise stable patterns in ML systems.

References

[1] M. Lazarus Arnau, Shannon Serrao, Uwe C. Täuber, Boundary Effects in Stochastic Cyclic Competition Models on a Two-Dimensional Lattice, (Wiley-VCH, 2008, Windheim) (ISBN: 978-0-471-60386-3)