Title slide (1/8)

Motivation (2/8)

- RPS & ML models motivated by systems in bio., pop. dyn., chem. that follow a cyclic A > B > C > A competition scheme.
- Despite sharing a cyclic competition scheme both models exhibit different long term pattern formation (particles clusetering disordered patchs vs. long lived spiral waves)
- We are interested in developing local control schemes that can affect the steady-state pattern formation of the MLM and systems like it.
- To this end we are investigating how changing the microscopic rules from MLM to RPS on a small region affects the formation of long lived macroscopic patterns in the rest of the lattice.

Models (3/8)

- Both models follow a "rock paper scissors" competition scheme
- In both models mobility is enabled via pair-swapping reaction.
- In RPS predation & reproduction are combined in to a single replacement reaction (hence particle count is conserved). In ML the two reactions are decoupled.
- This decoupling (and hence loss of particle conservation) is what causes the pattern formation in the MLM.

Combined System (4/8)

- Toroidal lattice governed mostly by MLM except for a narrow ring shaped patch governed by the RPS model.
- Initialized by assigning each site a random species. System is then evolved via a Monte-Carlo simulation.
- In all simulations we fix the reaction rates to be 1, ML mobility rate to be 5. Chosen as such because these rates are well within the regime in which the MLM produces stable well defined spiral waves. This allows us to focus on how changing the RPS mobility affects the system.

Combined System (Cont.) (5/8)

- Slide is backup for in case video doesn't work
- When we simulate the system we observe disruption of the spiral waves in the form of plane-waves emanating away from the interface.
- Plane waves remain present over long timescales.

Correlation Lengths and Permeation Distance (6/8)

- In order to quantify the length (parallel to the interface) distance of the plane waves we calculate the vertical auto-correlation (AC) function of each species for each column once the system has reached a steady-state.
- Because the plane waves are not always perfectly parallel to the interface, we average the AC functions of each species in order to remove random phase errors.
- These AC functions are then averaged over several hundred runs. From the averaged correlation functions we extract the vertical correlation length for each column. This gives as a rough but easily computed measure of plane-wave size.
- Doing this, we find that lower RPS mobility rates correspond to larger, more cohesive plane waves.
- By computing the correlation lengths we are also able to measure how far the plane waves travel in to the ML region before the system reverts to normal spiral wave formation. For all RPS mobilities we tested this is approximately constant at three times the characteristic wavelength of a ML system.

Well-Mixing Effects: Boundary Effects (7/8)

- We also observed a marked decrease in net population density near the RPS-ML interface.
- In order to explain this we recorded the net population density of pure ML systems starting from random initial conditions until they reach their steady state. Doing this reveals that the population quickly approaches its mean field density before recovering to its steady-state carrying capacity.
- This indicates that the drop in density near the interface is a result of the disorder in the RPS region causing the lattice to be more “well mixed” near the interface which causes the system to behave in a more mean-field like manner, hence the drop in population density.

Conclusions (8/8)

As is on slides.