

# Information Transfer in Spatially Extended Systems

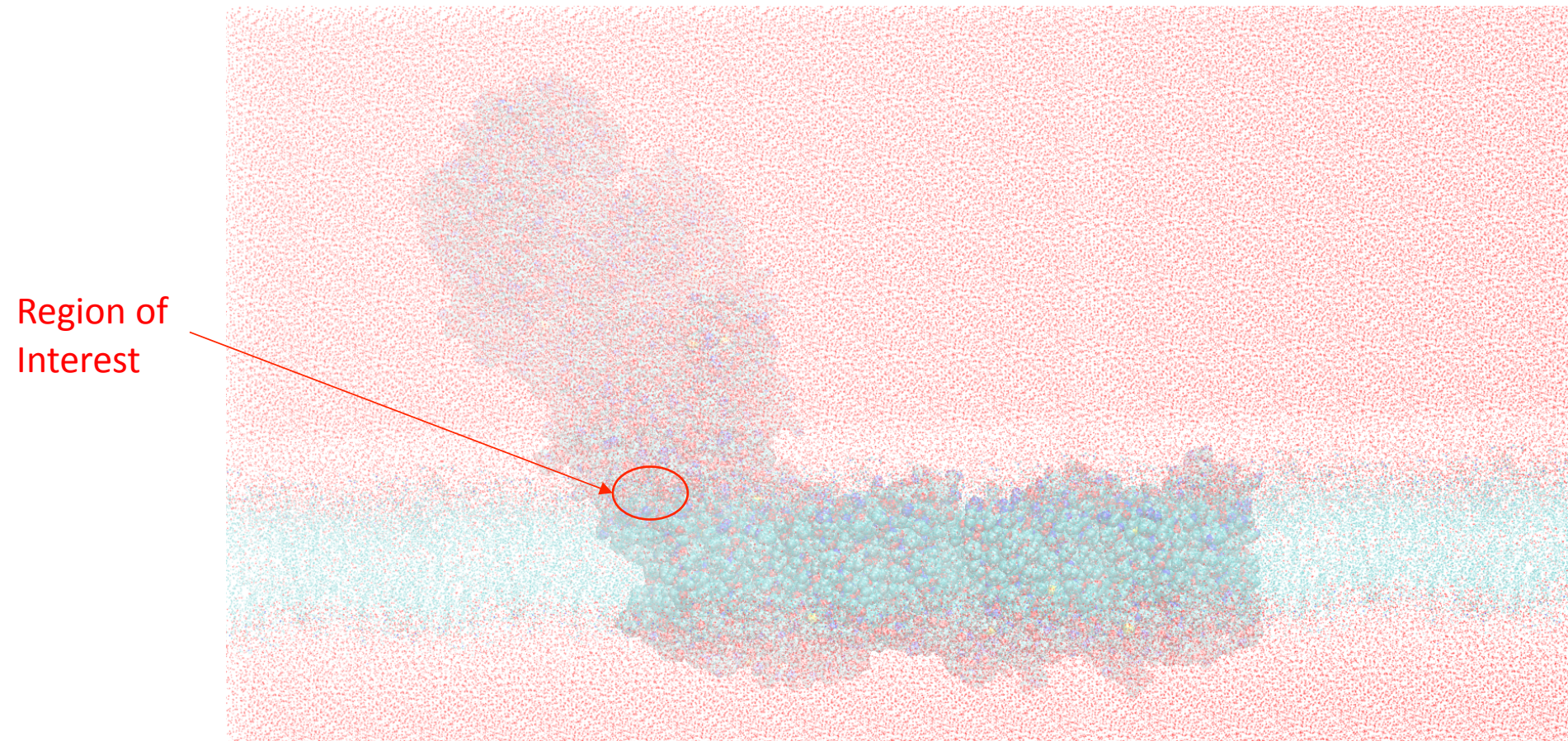
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# What can I ignore when studying local portion of a large Spatially Extended System?

- I care about movement of  $\sim 400$  atoms in  $\sim 2$  million atom system



# Look at Belousov-Zhabotinsky reaction as abstracted similar problem

- As an abstracted similar problem, study information transfer in Belousov-Zhabotinsky Reaction



# Greenberg-Hastings model simple and easily modifiable

Cellular Automata where each cell can take on a value  $S_t \in \{0,1,2\}$

- $$S_{t+1} = \begin{cases} S_t + 1 \pmod{3} & \text{if } S_t > 0 \\ 1 & \text{if } S_t = 0 \text{ and adjacent cell is } 1 \end{cases}$$

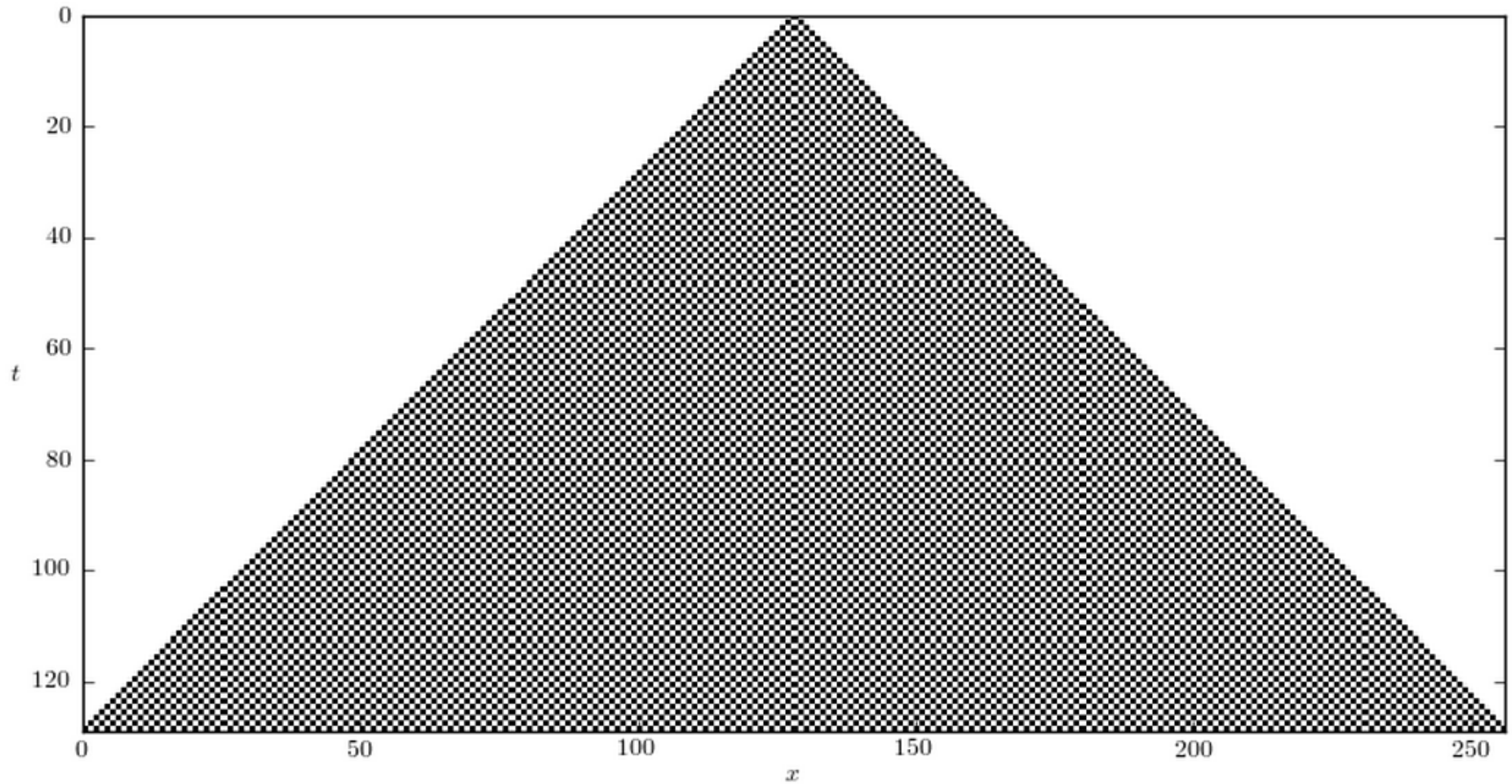
If confined to 1-D and instead of 3 states we have 2

- $$S_{t+1} = \begin{cases} S_t + 1 \pmod{2} & \text{if } S_t > 0 \\ 1 & \text{if } S_t = 0 \text{ and adjacent cell is } 1 \end{cases}$$
- This is Rule 50 in 1D binary Cellular Automata!

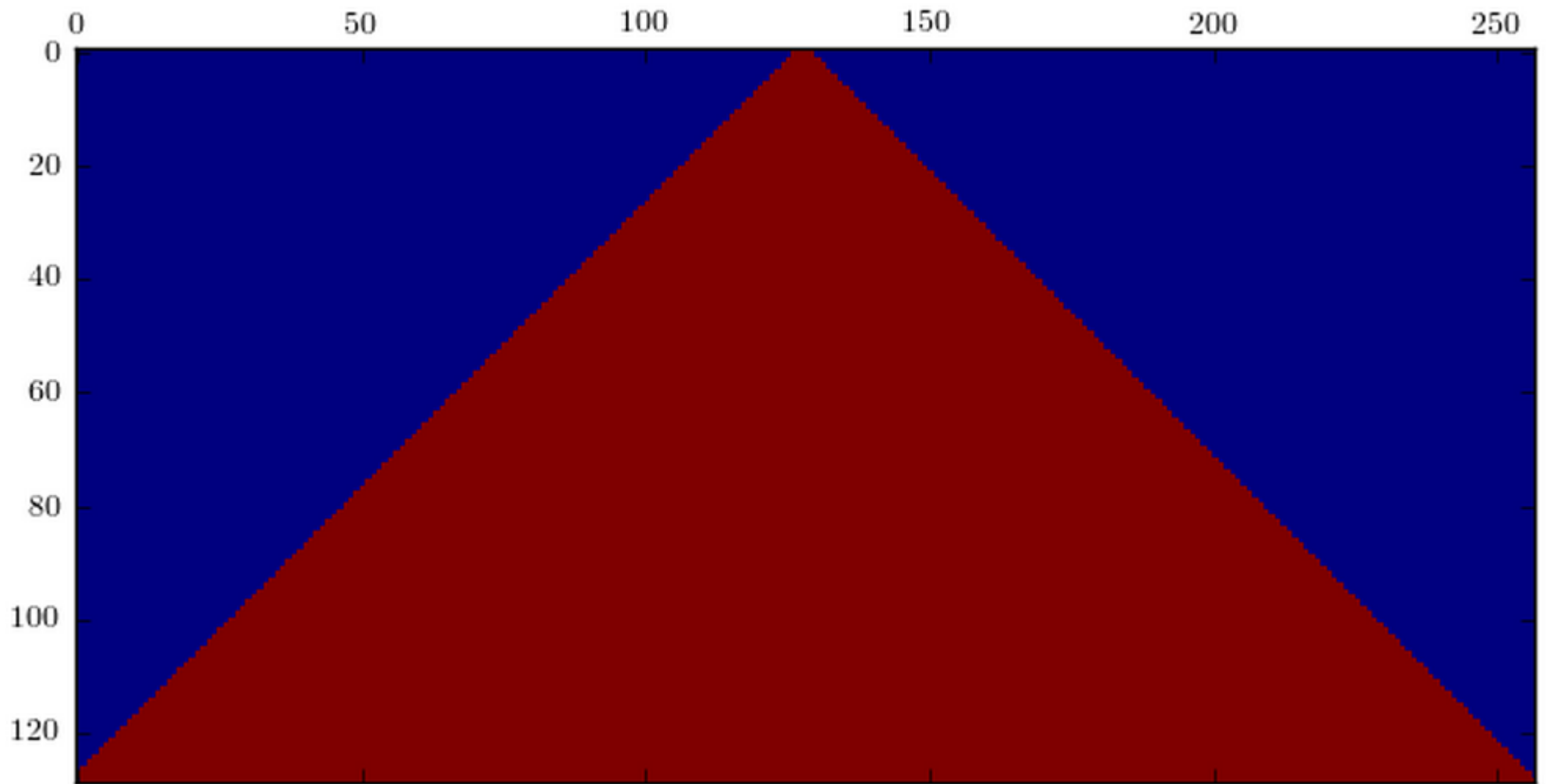
Can be seen as special case of rock-paper-scissors like games

# BZ-like patterns, traveling wave

Rule 50

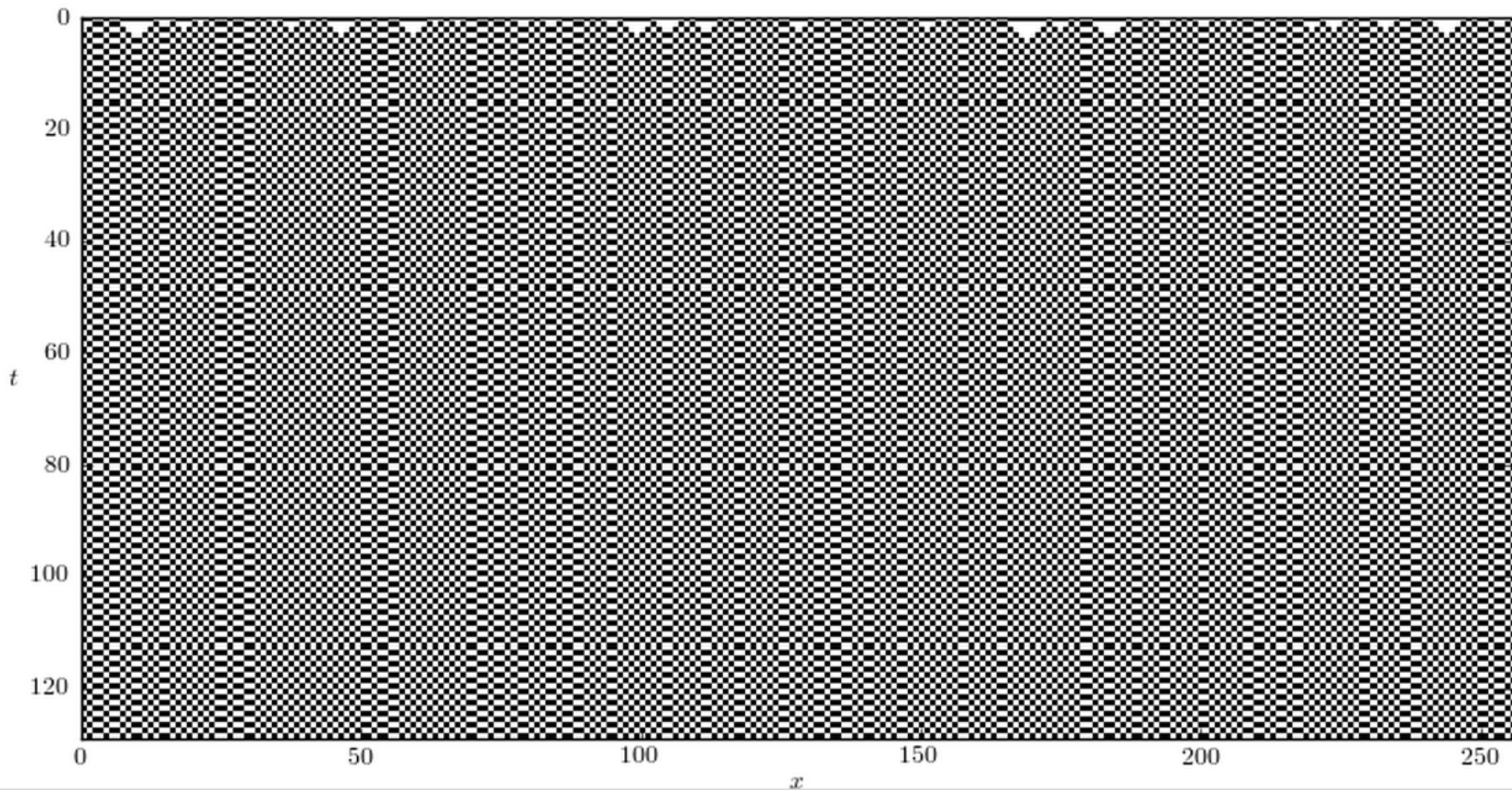


# BZ-like patterns, traveling wave, Domains

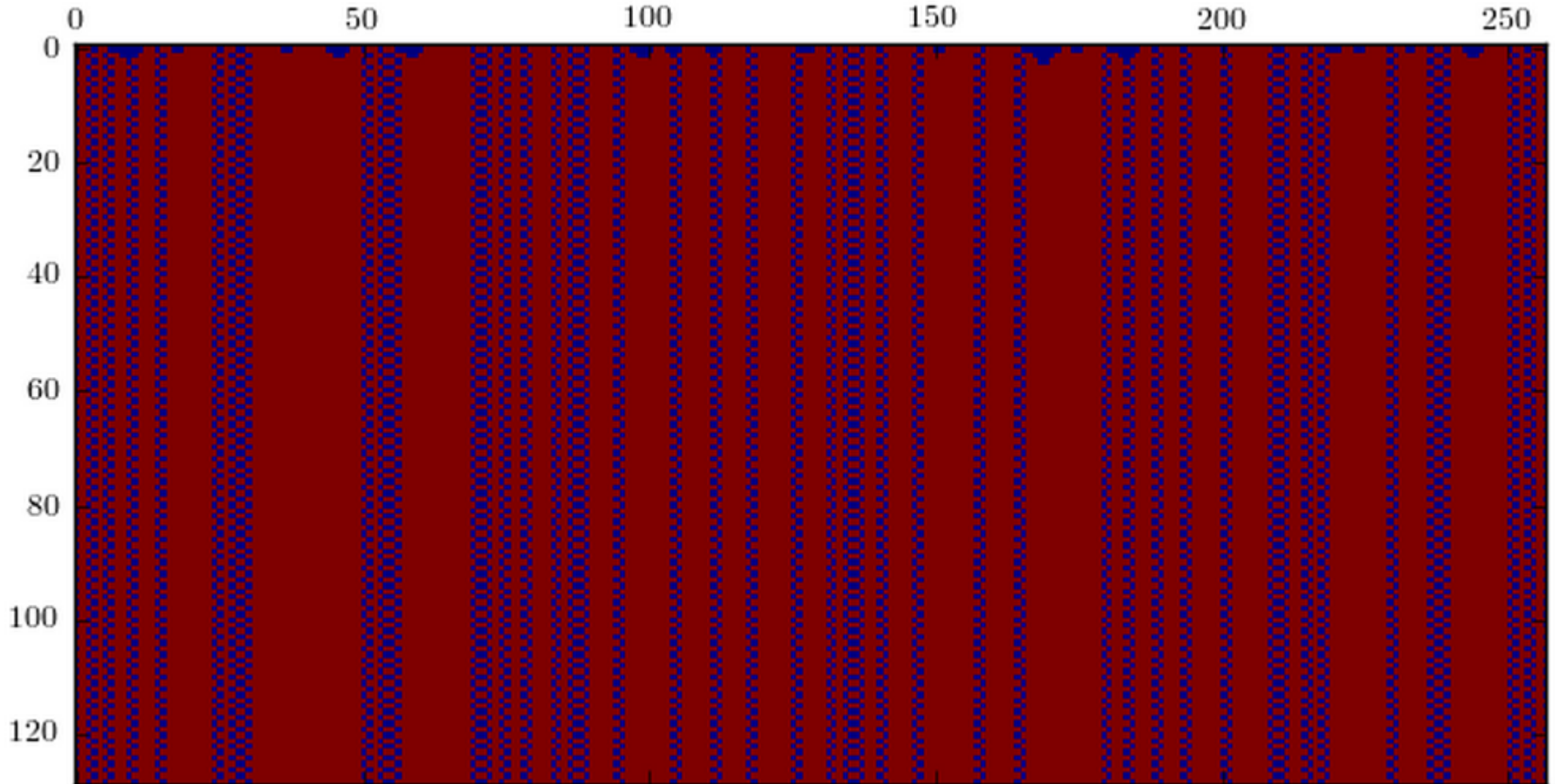


# BZ-like patterns, many standing waves

Rule 50



# BZ-like patterns, standing waves, domains





# Observations

Non-stationarity : noepsilon machine w/  $\leq 4$  states at non-trivial sites

## Possible Next Steps

Explore non-stationarity (time to next “excitation”)

Calculate block entropies for both original CA and particle version

Calculate mutual information between spatially separated points

Increase number of states

Increase number of dimensions

# Acknowledgements

Thanks to Jim Crutchfield for guiding direction

# References

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