Information Propagation through cell tissues as a model for active nematic liquid crystals

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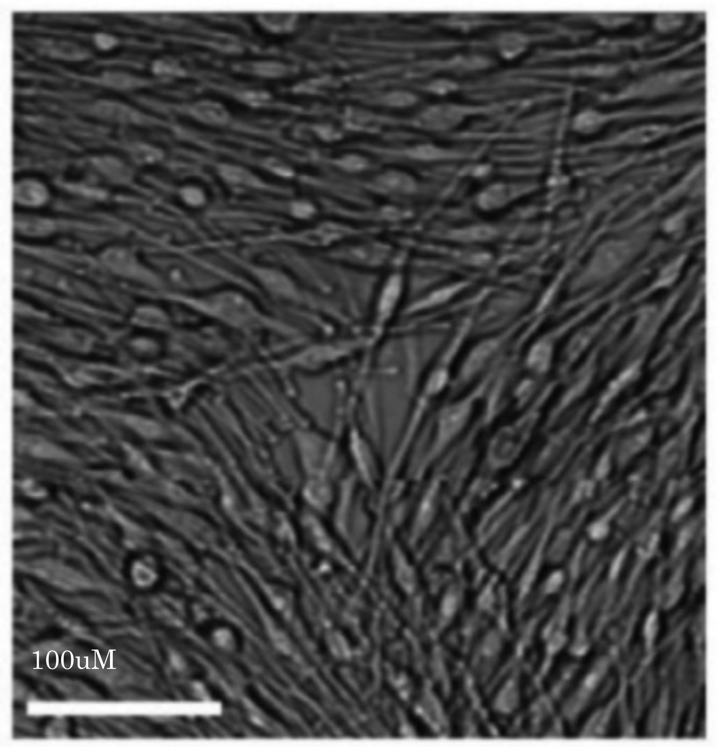
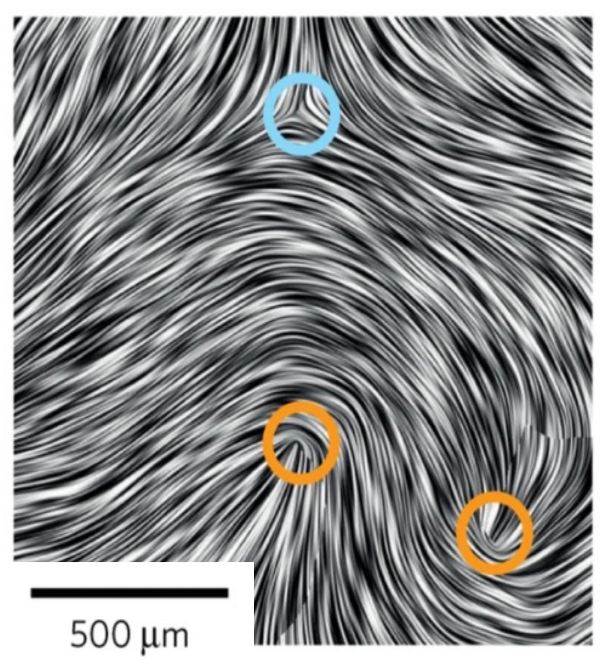
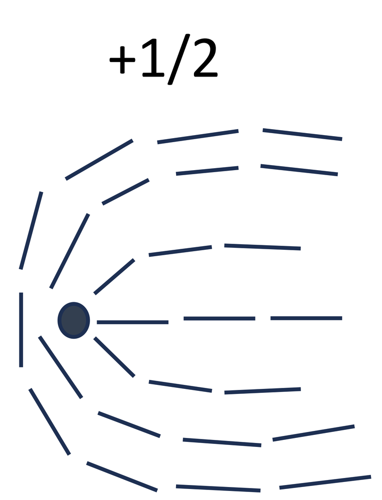
Nematic Liquid Crystals

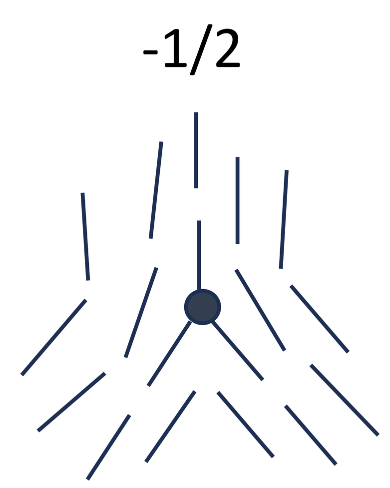


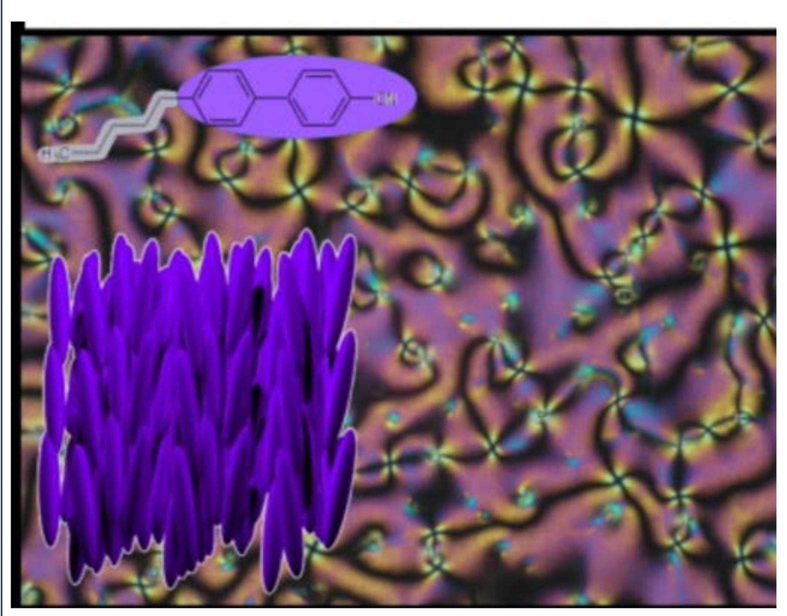
Kemkemer et al, 2000





Nematic phase





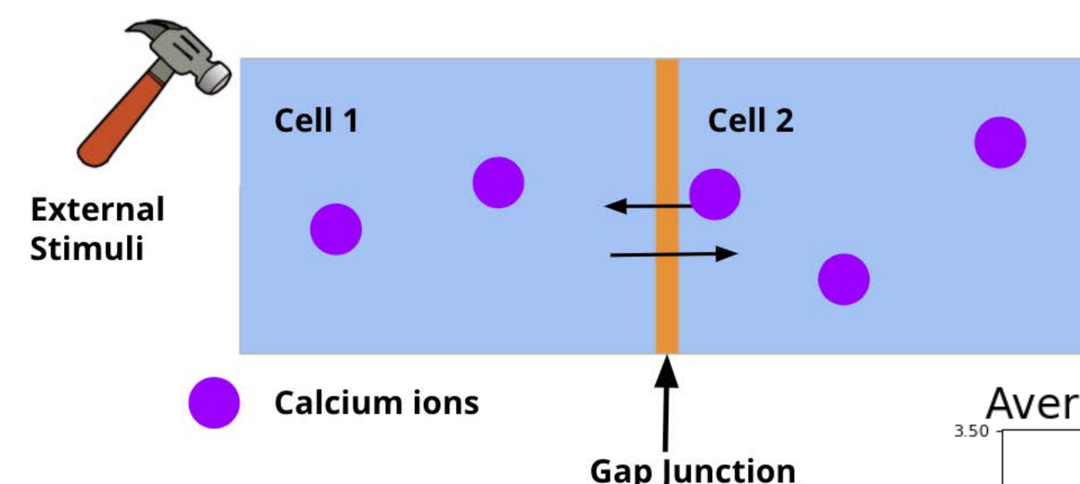
https://www.alternator.science/sl/daljse/liquid-crystals-the-beautiful-state-of-matter/

Conventional liquid crystals (LC) are birefringent, meaning that electromagnetic waves propagate at different speeds along or perpendicular to the director of the LC

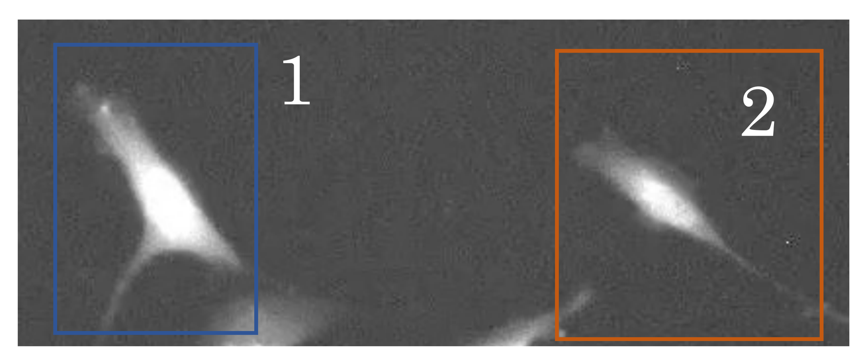
. **I hypothesize** that molecular signals will also propagate anisotropically through dense tissues composed of elongated cells, due to the excess gap junctions along the cell long axis. Consequently, I hypothesize that the architecture of the cellular network will also impact how cells sense and propagate signals.

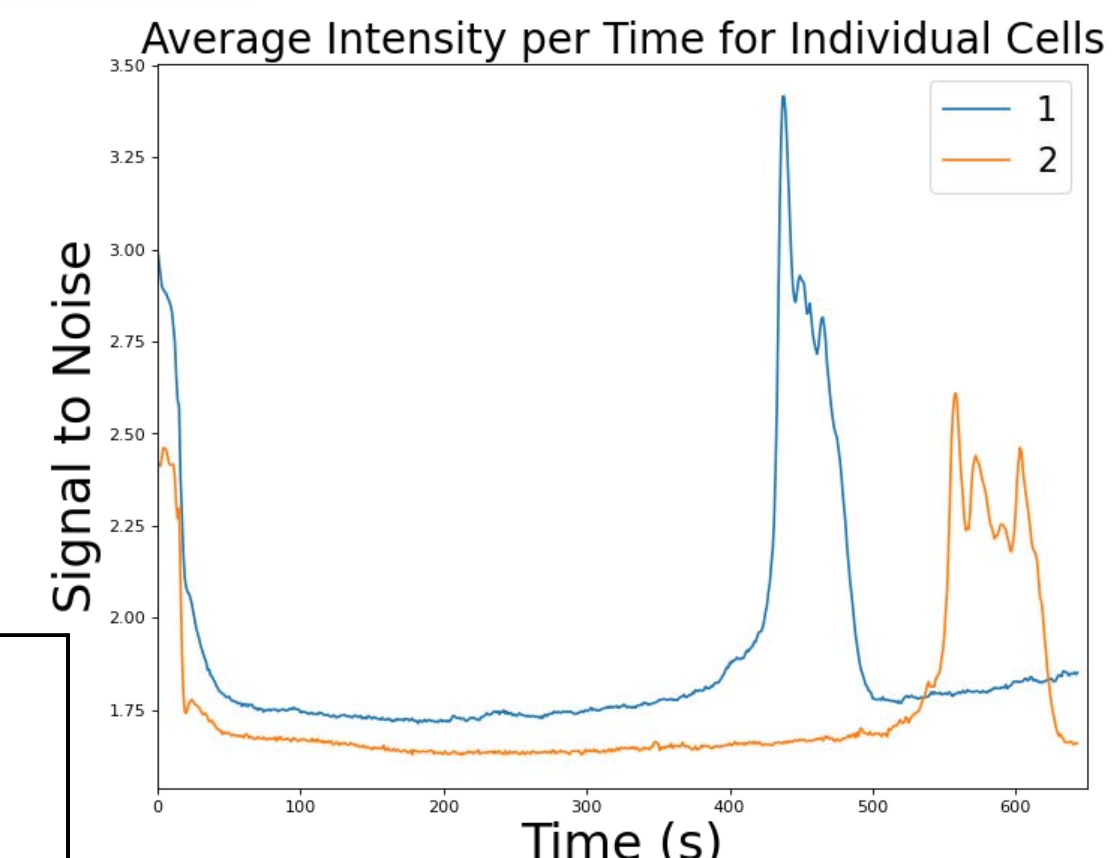
Calcium Signaling

External stimuli, such as a flow of ATP or a mechanical stress causes epithelial cells to release calcium ions.



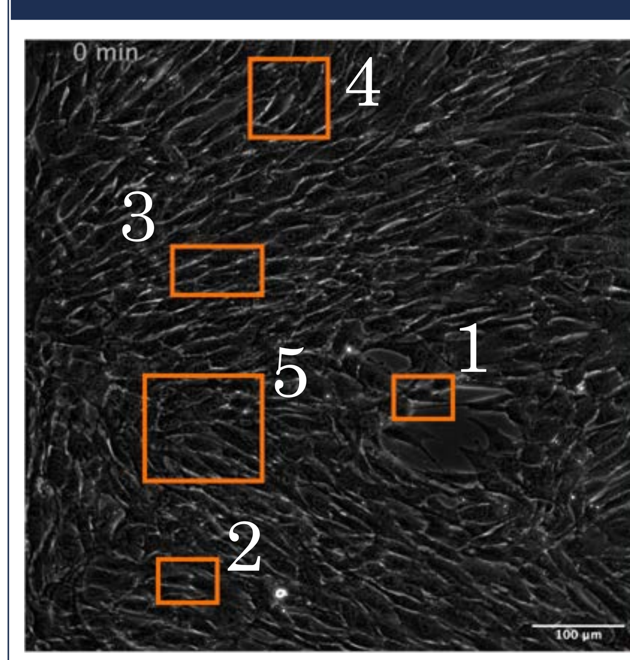
Through fluorescently labeling calcium ions, the movement of ion flow can be tracked through the system, resulting in a quantitative method to analyze information propagation among dense monolayers of tissue.



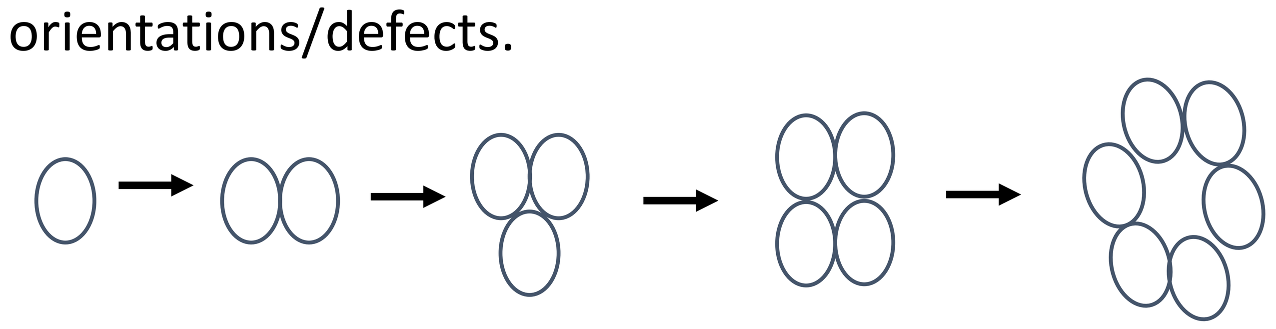


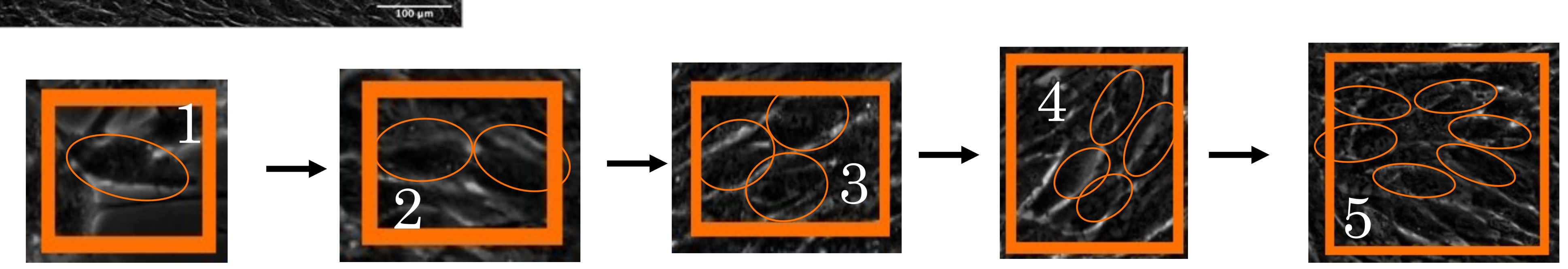
$$\text{Signal to Noise} = \frac{\text{Avg Intensity of the Cell}}{\text{Avg Intensity of the Background}}$$

Starting Simple



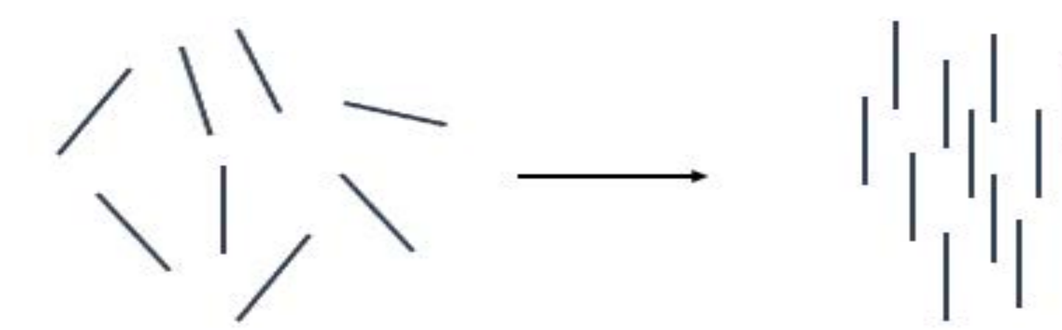
We'll start by slowly increasing network complexity to understand how information is communicated among complex networks. We can build our way up to nematic orientations/defects.

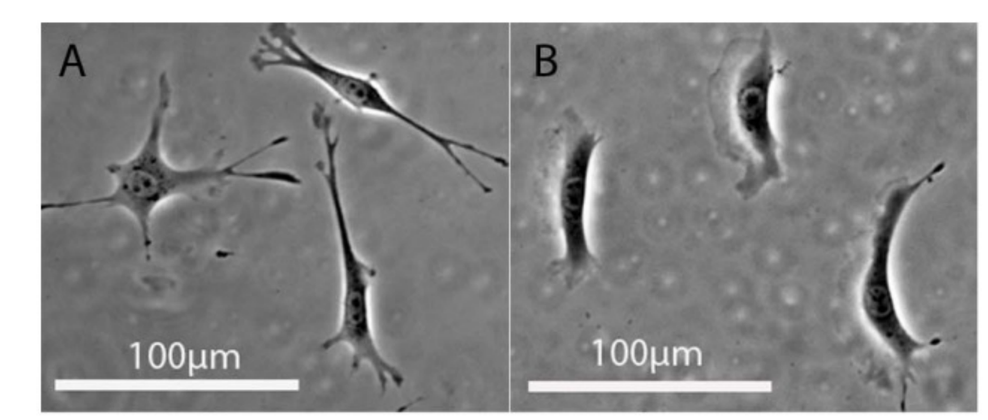




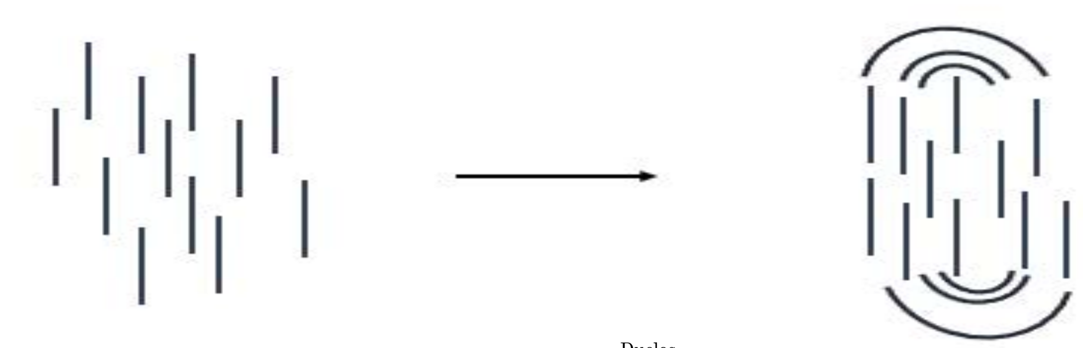
Biological Networks

Once small-scale networks are understood, we can move toward studying bulk orientations, building our way up to topological defects such as those found in active nematic liquid crystals.

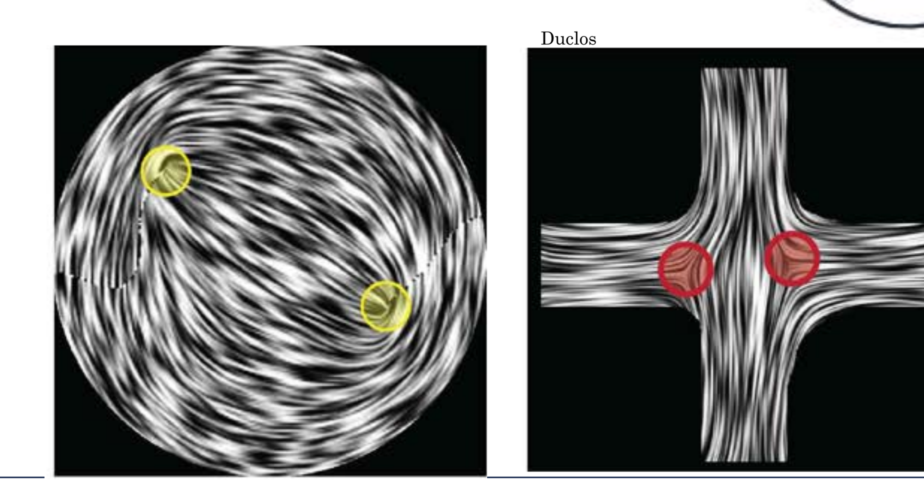




Huang et al



Duclos



References

1. Sun et al, Phys. Rev. Lett, 2013
2. Duclos et al, Nature Physics, 2013
3. Saw et al, Nature Physics, 2017

Acknowledgments

I want to thank the Duclos Lab for being incredibly supportive ☺