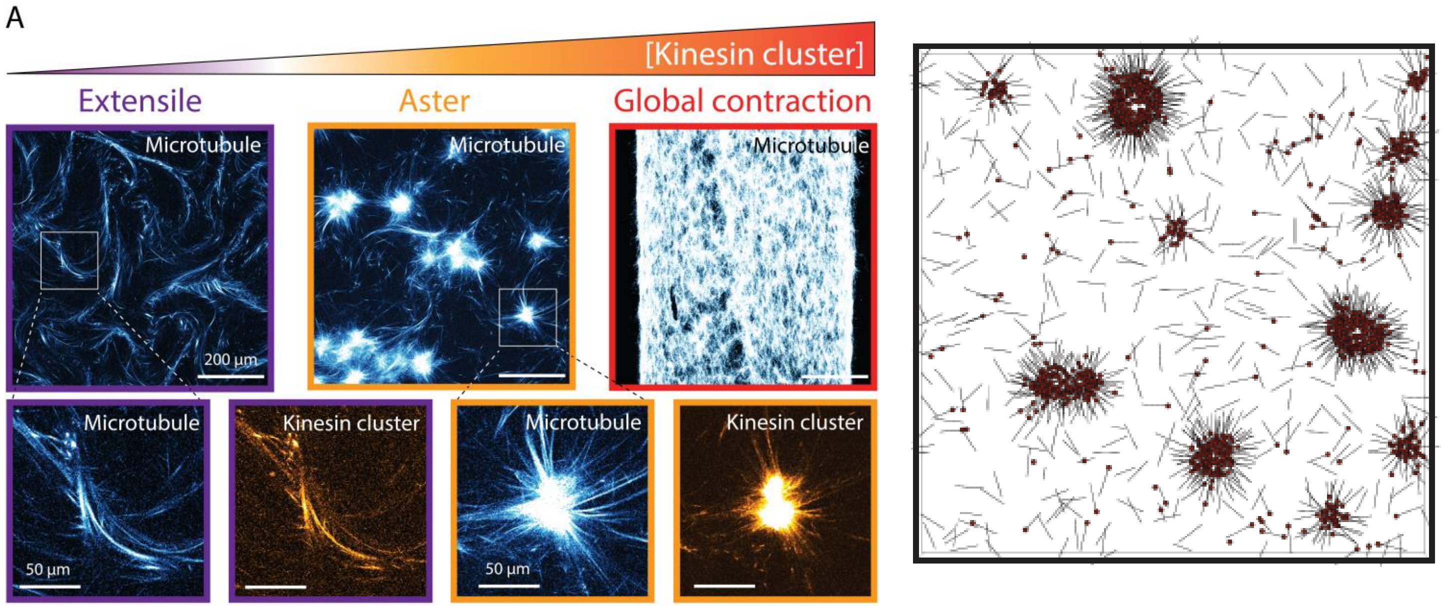
From microscopic interactions to emergent macroscopic dynamics

[1]Duclos, [1]Baskaran, [1]Hagan, [1]Fraden, [2]Dogic. [1]Brandeis University, [2]UCSB

Self-organization in living cells is often driven by energy-consuming motor proteins that push and pull on a network of cytoskeletal filaments. However, it is unclear how to connect the emergent structure and dynamics of reconstituted cytoskeletal materials to the kinetics and mechanics of their microscopic building blocks. We systematically correlate bulk structure with asymmetry of the motor distribution along single filaments to explain the transition from extensile bundles to contractile asters in active networks of microtubules crosslinked by motor proteins. We combine experiments and theory to identify a single parameter that predicts how the system will self-organize. This work shows that biochemical and mechanical interactions compete to set the emergent structure of active biomimetic gels. The Center will exploit these results to build autonomous soft materials with lifelike attributes



Nematic alignment competes with polar sorting to control the self-assembly into extensile bundles or contractile asters. Experiments on the left, computer simulations on the right.

Citation: Najma, B., Wei, W., **Baskaran, A.**, Foster, P. J., & **Duclos, G.** (2024). Microscopic interactions control a structural transition in active mixtures of microtubules and molecular motors. Proceedings of the National Academy of Sciences, 121(2). https://doi.org/10.1073/pnas.2300174121