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Modeling Active Microtubule-motor Networks

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Cell division of one cell into two daughter cells is necessary for organisms to grow or reproduce. Segregation of the genetic material into the daughter cells during cell division is performed by a molecular machine called the mitotic spindle that exerts forces on chromosomes and moves them to the correct locations during cell division. The mitotic spindle is a nonequilibrium structure composed of filaments called microtubules and motor proteins that bundle and slide the filaments. The mitotic spindle is inspiring new work in which components of the mitotic spindle are taken outside of cells to make new types of biologically-inspired active materials. To improve our understanding of these active materials, we are studying course-grained models of liquid-crystalline filaments (microtubules) driven by active crosslinks (motors). This model is investigated using a combination of Brownian dynamics and kinetic Monte Carlo simulation. We observed novel states of the system, including bundles and sheets, active nematic phases, and laning.

In collaboration with Robert Blackwell and Matthew Glaser, University of Colorado - Boulder.