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Biomimetic Phases of Microtubule-Motor Mixtures

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We try to determine the universal principles of organization from the molecular scale that gives rise to architecture on the cellular scale. We are specifically interested in the organization of the microtubule cytoskeleton, a rigid, yet versatile network in most cell types. Microtubules in the cell are organized by motor proteins and crosslinkers. This work applies the ideas of statistical mechanics and condensed matter physics to the non-equilibrium pattern formation behind intracellular organization using the microtubule cytoskeleton as the building blocks. We examine these processes in a bottom-up manner by adding increasingly complex protein actors into the system. Our systematic experiments expose nature's laws for organization and has large impacts on biology as well as illuminating new frontiers of non-equilibrium physics.