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Kinetic theory for actively streaming microtubule suspensions

TONG GAO, Courant Institute of Mathematical Sciences, ROBERT BLACKWELL, MATT GLASER, MEREDITH BETTERTON, Department of Physics and Liquid Crystal Materials Research Center and Biofrontiers Institute, MICHAEL SHELLEY, Courant Institute of Mathematical Sciences — Suspensions of polar biopolymers mixed with molecular motor proteins can exhibit surprising out-of-equilibrium phenomena. In a recent experiment by Sanchez et al., microtubules are driven into collective motion by plus-end walking motor complexes. In experiments where the suspension is confined to a fluid-fluid interface, they find the emergence of distinctive large-scale flows characterized by persistent time-dependence and formation/annihilation of disclination singularities in the nematic order. Here we develop a first-principles kinetic theory to investigate the nonlinear dynamics and pattern formation observed in active microtubule suspensions. We model the active stresses generated by motile microtubules by taking into account the extensile stresses due to both the antiparallel and the parallel microtubule pairs. In a concentrated system, the resultant particle-pair stresses can induce hydrodynamic instabilities, and lead to a large-scale flows. When the suspension is confined to a liquid-liquid interface, we recover much of the dynamics observed in the experiments.

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