Filamentous Active Matter: Band Formation, Bending, Buckling, and Defects

G. A. Vliegenthart, A. Ravichandran, M. Ripoll, T. Auth and G. Gompper

Theoretical Soft Matter and Biophysics, Institute for Advanced Simulation and Institute of Complex Systems, Forschungszentrum Jülich, D-52425 Jülich, Germany

Motor proteins drive the persistent motion of cytoskeletal filaments in vivo as well as in vitro.

We perform component-based Brownian dynamics simulations of polar semiflexible filaments and molecular motors. This allows for linking the microscopic interactions and the filament activity to self-organisation and dynamics from the fundamental two-filament level all the way up to the of mesoscopic domain level. Dynamic filament crosslinking and sliding, and excluded-volume interactions promote formation of motor-bound bundles at small filament densities, and of active polar nematics at high densities. An Euler buckling-type instability sets the size of the polar domains and the density of topological defects. We predict a universal scaling of the active diffusion coefficient and the domain size with the active force, and its dependence on parameters like motor concentration, filament concentration and persistence length.