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How Interactions Affect Multiple Kinesin Dynamics

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Intracellullar transport is supported by several classes of enzymatic molecules known as motor proteins. Cellular cargos are frequently transported by teams of motor proteins, and recent experimental and theoretical studies uncovered many features of such complex dynamics. Here we investigate theoretically the role of nonmechanical interactions between kinesin motor proteins and microtubules in the collective motion of motor proteins. Our analysis is based on stochastic model that explicitly takes into account all chemical and mechanical transitions. Nonmechanical interactions are assumed to affect kinesin mechanochemistry only when the motors are separated by less than 3 microtubule lattice sites, and it is shown that relatively weak interaction energies can have a significant effect on collective motor dynamics. In agreement with optical trapping experiments on structurally defined kinesin complexes, the model predicts that these effects primarily occur when cargos are transported against loads exceeding single-kinesin stalling forces. These results highlights the complex dynamics of multiple motor proteins in cellular transport phenomena.