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Dynamic Simulations of the Instability of Sedimenting Fibers

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The concentration instability of sedimenting fiber suspensions under gravity at zero Reynolds number is investigated by means of large-scale numerical simulations. Periodic boundary conditions are used to simulate an infinite suspension. Far-field hydrodynamic interactions are modeled using slender-body theory, and the lubrication approximation is used for short-range pairwise interactions. A fast summation algorithm is implemented to compute the hydrodynamic interactions, allowing the simulation of systems of several hundred fibers. Using very wide boxes we are able to observe several high density streamers in the lateral direction, and show that the wavenumber selection is determined to a large extent by low-wavenumber concentration fluctuations in the initial distribution, which create backflows in the disturbance velocity field. We also study the dynamics of clusters inside these vertical streamers, and observe a mechanism during the transient phase of the instability by which small clusters merge into larger ones.

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