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Strongly nonlinear interfacial-surfactant instability and diffusion
ALEXANDER FRENKEL, DAVID HALPERN, University of Alabama — The nonlinear stages of the recently uncovered instability due to insoluble surfactant at the interface between two fluids in a creeping plane Couette flow are investigated for the case when one of the fluids is a thin film and the other is semi- infinite in the cross-flow direction. Numerical simulation of strongly nonlinear longwave evolution equations which couple the film thickness and the surfactant concentration, assuming the latter sufficiently small, reveals that the instability saturation is only possible when the surfactant diffusion exceeds a threshold strength whose value depends on the interfacial shear rate and other parameters. The disturbance of surfactant concentration never remains small, so the evolution never can be completely described by weakly nonlinear equations. The evolution time scale appears to grow indefinitely as the interfacial shear goes to zero and/or the surfactant diffusion strength increases.

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