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Nonlinear evolution and traveling waves of sheared-film flows with insoluble surfactant ALEXANDER FRENKEL, DAVID HALPERN, University of Alabama — We study traveling wave solutions which bifurcate from a plane- Couette film flow with an insoluble surfactant. The flat interface with a non-zero shear becomes unstable when the disturbance wavelength exceeds a marginal value. (This theoretically predicted instability was recently confirmed in experiments by Stocker and Bush (JFM vol. 583, 2007).) Traveling wave equilibria bifurcate from the flat film flow as the spatial period increases from the marginal-stability value. The disturbances are governed by a system of PDEs for the film thickness and the surfactant concentration which is controlled by a single parameter C. The Hopf bifurcation to traveling waves is supercritical for $C < C_s$ and subcritical for $C > C_s$, where $C_s \approx 0.29$. For the subcritical cases, there are two values of equilibrium amplitude for a range of C near C_s, but the traveling-wave with the smaller amplitude is unstable as a periodic orbit of the associated dynamical system whose independent variable is the spatial coordinate. Numerical simulations of time-dependent evolution equations show that the saturation of the disturbances is invariably large amplitude. This suggests that, in general, for flowing film instabilities of the Kuramoto-Sivashinsky type that have zero wavenumber at criticality, the saturated disturbance amplitudes do not always have to decrease to zero as the control parameter approaches its critical value.

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