NONLINEAR PHENOMENA IN TWO-FLUID SHEAR FLOWS IN THE PRESENCE OF SURFACTANTS

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ABSTRACT. The flow of two superposed fluids in a channel in the presence of an insoluble surfactant is studied. Asymptotic analysis in the limit of a thin lower layer is performed and a system of coupled weakly nonlinear evolution equations is derived. The system describes the evolution of the film thickness and the surfactant concentration. The two cases of asymptotically small and order one Reynolds number in the upper layer are examined in detail. The nonlocal system of nonlinear evolution equations is solved numerically by implementing accurate linearly implicit BDF schemes; numerical experiments indicate that the solutions are mostly nonlinear travelling waves of permanent form or time-periodic travelling waves. As the length of the system increases, the dynamics of the system are more complex and include quasi-periodic and chaotic solutions. Results that developed by solving the localised system and comparing with the nonlocal one, reveal that the solutions of the two systems are dynamically identical but profiles possibly have a phase difference.