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Title: *Systems of nonlinear PDEs arising in multilayer channel flows*

Abstract

In this talk, we will focus on systems of nonlinear PDEs modeling the dynamics of three stratified immiscible viscous layers flowing inside a channel with parallel walls inclined to the horizontal. The three layers are separated by two fluid-fluid interfaces that are free to evolve spatiotemporally and nonlinearly when the flow becomes unstable. The determination of the flow involves solution of the Navier-Stokes in domains that are changing due to the evolution of the interfaces whose position must be determined as part of the solution, providing a hard nonlinear moving boundary problem. Long-wave approximation and a weakly nonlinear analysis of the Navier-stokes equations along with the associated boundary conditions, leads to reduced systems of nonlinear PDEs that in general form are systems of coupled Kuramoto-Sivashinsky equations. These physically derived coupled systems are mathematically rich due to the rather generic presence of coupled flux functions that undergo hyperbolic-elliptic transitions, along with high order dissipation. Analysis and numerical computations of the resulting coupled PDEs will be presented in order to understand the stability of multilayer channel flows and explore and quantify the different types of underlying nonlinear phenomena that are crucial in applications. Importantly, it will be shown that multilayer flows can be unstable even at zero Reynolds numbers, in contrast to single interface problems. Finally, we will focus on the dynamical behaviour of the zero viscosity limits of the derived systems in order to verify their physical relevance as reduced models. Strong numerical evidence of the existence of the zero viscosity limit will be provided for mixed hyperbolic-elliptic type systems whose global existence is an open and debatable mathematical problem.